21 *May* 1957 *Price* 30*s.* 0*d.*

PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON

168th Session (1955–56)

Vol. 168 Parts 1 and 2

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1957

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PROCEEDINGS OF
THE LINNEAN SOCIETY OF LONDON
Session 1955–56

Vol. 168 Parts 1 and 2

PROCEEDINGS OF THE GENERAL MEETING HELD ON 6 October 1955

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the Anniversary Meeting held on 24 May 1955, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Mr. L. Benson, Miss M. S. Campbell, Dr. K. A. Chowdhury, Professor G. W. Gale, Dr. J. J. Jenkin, C.B.E., Dr. R. Klein, Mr. C. McCann, Dr. A. E. Porsild, Dr. M. M. Salah, Mr. E. Shurly, Dr. W. G. Templeman, Mr. P. Vermeulen, The National Trust for Scotland, Messrs. G. Bell & Sons, Ltd., and Messrs. Longmans, Green & Co., Ltd.

The following signed the Obligation in the Roll and Charter Book and were admitted Fellows:—Professor William Edwyn Isaac, Ph.D., and Mr. Cyril Winthrop Mackworth-Praed, M.A.

The President reported the deaths of Lt.-Col. Charles Hervey Grey, D.S.O., George Woodrouffe Harris, Major Albert Pam, O.B.E., Arthur William Rymer Roberts, Dr. Otto Rosenheim, F.R.S., Dr. Lawrence Root Waldron and George Stanley Woodcock, Fellows, and Dr. Valentin Dogiel, Foreign Member of the Society.

The following communications were read and discussed:—

Professor Wm. Edwyn Isaac. The distribution, ecology and taxonomy of South African *Porphyra*. (Discussed by Dr. E. M. Delf, the President, the Botanical Secretary, Dr. M. A. P. Madge and Miss M. E. Fox; Prof. Isaac replied.) **[Extended abstract printed on p. 61.]**

Mr. G. Owen Evans. Some aspects of the systematics and biology of mites. (Discussed by Dr. C. F. A. Pantin, Dr. B. M. Hobby, Miss D. J. Jackson, Mr, A. H. G. Alston, Dr. E. M. Delf, Mr. P. R. Bell and Dr. E. B. Worthington; Mr. Owen Evans replied.) **[Printed in full in *Journal, Zoology* No. 291.]**

Abstract—

An illustrated introductory account of the external morphology and the classification of the Acarina was given, together with examples of the life cycle and feeding habits of free-living and parasitic species.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 20 October 1955

Dr. H. Hamshaw Thomas M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 6 October 1955, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Dr. N. Ahmad, Dr. J. Hutchinson, F.R.S., Mr. R. H. Jeffers, Mr. R. W. J. Keay, Sir Norman Kinnear, C.B., the American Embassy and the Carnegie Institution of Washington.

The PRESIDENT reported the death of Major Arthur Algernon Dorrien-Smith, D.S.O., V.M.H., Fellow of the Society.

Certificates of recommendation for election to Fellowship were read for the first time in favour of the following:—Charles Dennis Adams, B.Sc., Charles Edmond Bradlaugh Bonner, Dr. ès Sc., M.Sc., L. ès Sc., Donald Eric Caulton, B.Sc., A.L.S., John Colhoun, D.Sc., Ph.D., Miss Margaret Elizabeth Fox, B.Sc., Frank Nigel Hepper, B.Sc., Reginald Smithson Julian Hawes, B.Sc., Ph.D., Basil H. Harley, B.A., Trevor John Longhurst, B.Sc., Henry Arthur Osmaston, M.A., David Philcox, Miss June R. Rees, M.Sc., Edward Joseph Shellard, B.Pharm. and John Francis Levy, B.Sc.

The following communications were read and discussed:—

Mr. E. J. H. CORNER, F.R.S. Taxonomy and tropical plants. (Discussed by Dr. W. B. Turrill, Dr. R. E. Holttum, Professor P. W. Richards, Mr. R. W. J. Keay, the Botanical Secretary, Dr. G. A. C. Herklots, Mr. B. L. Burtt, Mr. J. B. Gillett and Mr. J. P. M. Brenan; Mr. Corner replied.) **[Printed in full on page 65.]**

Mr. A. W. Exell. The "Flora Zambesiaca" project. (Discussed by Dr. W. B. Turrill, the Botanical Secretary, Mr. B. L. Burtt, Mr A. H. G. Alston, Mr. J. B. Gillett and Mr. J. P. M. Brenan; Mr. Exell replied.)

Abstract—

An account of a projected flora of Rhodesia, Nyasaland and Mozambique, the history of the project, a brief account of the main topographical and climatic features of the region, and the principal vegetational types, and a short discussion of the relationship between the *Brachystegia* and "*Mopane*" associations were given, illustrated by lantern slides.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 5 November 1955

Dr. H. HAMSHAW THOMAS, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 20 October 1955, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Dr. G. W. Reynolds and the Imperial Chemical Industries, Ltd.

Mr. William Grant Inglis signed the Obligation in the Roll and Charter Book and was admitted a Fellow.

Certificates of recommendation for election to ordinary Associateship were read for the first time in favour of Michael Brandon-Bravo, Michael John Christmas, Laurence A. Mound, Peter Reeve, John Russel Webster, B.Sc. and Roger John Wood, and certificates of recommendation for election to Fellowship were read for the second time in favour of those candidates whose names appear in the Minutes of the Meeting held on 20 October 1955.

The following communication was read and discussed:—

Professor H. GRAHAM CANNON, F.R.S. What Lamarck really said. (Dis-

cussed by the President, Dr. G. S. Carter, Dr. A. Tindell Hopwood, Professor A. C. Hardy, Mr. E. J. H. Corner, Dr. J. Ramsbottom and Dr. L. Harrison Matthews; Professor Graham Cannon replied.) **[Printed in full, with Discussion on p. 70.]**

PROCEEDINGS OF THE GENERAL MEETING HELD ON 17 November 1955

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on 3 November 1955, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. N. Ahmat, Professor Roger Heim, F.M.L.S., Mr. S. R. Munro and Professor J. Rzoska.

The following signed the Obligation in the Roll and Charter Book and were admitted Fellows :—Mr. Frederick Ronald Jones, B.Sc., and Mr. Harold George Hillier.

The President announced that Mr. H. N. Ridley, C.M.G., F.R.S., F.L.S., would celebrate the One hundredth Anniversary of his Birth on 10 December 1955, and it was unanimously agreed with acclamation that a Congratulatory Message be sent from the Fellows on his birthday.

The following candidates for Fellowship and Ordinary Associateship were balloted for and elected; Fellows :—Charles Dennis Adams, B.Sc., Charles Edmond Bradlaugh Bonner, Dr. ès Sc., M.Sc., L.ès Sc., Donald Eric Caulton, B.Sc., A.L.S., John Colhoun, D.Sc., Ph.D., Miss Margaret Elizabeth Fox, B.Sc., Basil H. Harley, B.A., Frank Nigel Hepper, B.Sc., A.L.S., Reginald Smithson Julian Hawes, B.Sc., Ph.D., John Francis Levy, B.Sc., Trevor John Longhurst, B.Sc., Henry Arthur Osmaston, M.A., David Philcox, Miss June R. Rees, M.Sc., Edward Joseph Shellards, B.Pharm; Ordinary Associates :—Michael Brandon-Bravo, Michael John Christmas, Laurence A. Mound, Peter Reeve, John Russell Webster, B.Sc., and Roger John Wood.

The following communication was read and discussed :—

Mr. F. Kingdon-Ward, O.B.E. Travels in the great forest belt of North Burma. (Discussed by Mr. E. J. H. Corner, Mr. I. H. Burkill, the President, Dr. A. Tindell Hopwood, Mr. P. R. Bell, The Earl of Cranbrook, the Botanical Secretary and Mr. A. H. G. Alston; Mr. Kingdon-Ward replied.) **[Printed in full on p. 87.]**

The Rev. W. Keble Martin, F.L.S., exhibited a selection from his coloured drawings of Willows and Sedges, etc.

PRESIDENT'S RECEPTION, 1 December 1955

The President, Dr. H. Hamshaw Thomas, M.B.E., F.R.S., received the Guests in the Library.

A coloured film of the British Museum (Natural History) and Royal Horticultural Society's Nepal Expedition, 1954, with a commentary by Mr. L. H. J. Williams, was shown in the Meeting Room.

Exhibits in the Library and Council Room.

The Council was greatly indebted to the London University Botanical Supply Unit for providing the decorative plants and young tropical trees exhibited throughout the Library.

Chelsea Polytechnic, Department of Zoology. Animals from the plankton of different seas by members of the Zoology Department of Chelsea Polytechnic.

(*a*) Dr. Muriel F. Sutton exhibited slides and a whole mount illustrating placentation in salps. Salps are viviparous Urochordates. The embryo develops on the dorsolateral wall of the atrium in association with a placenta, entirely maternal in origin. The placenta is formed of cells proliferated from the follicular lining. The blastomeres separated from each other by the inpushing follicle cells, migrate to the most distal region of the placenta (Slide I). There the uterine wall which up to this time encloses the placenta, degenerates, and the blastomeres now aggregated at the placental apex arrange themselves to form an embryo (Slide II). Once the cells are in position, tissue differentiation follows. In *Salpa maxima*, incubation folds, resembling the amnion folds of some vertebrates enclose the embryo in an incubation cavity. The incubation folds are however, in salps, entirely maternal in origin. Ultimately, the remains of the placenta, whose functions are the subject of investigation, are drawn into the embryo, the incubation folds part and slide down to the placental base (Slide III and whole mount), and the embryo swims out through the atrial siphon of the parent into the sea.

The whole animal exhibited, showed a late stage of the sexual development of salps outlined above.

(*b*) Dr. Eleanor M. Brown exhibited a slide showing a sample of phytoplankton taken over a wide area—a stretch of about 100 miles—in the north North Sea (58° 30 N. 0·30 E.) in August 1955. The material was made available through the courtesy of Dr. J. A. Fraser of the Scottish Home Department, Marine Laboratory, Aberdeen.

Armoured dinoflagellates were the dominant forms and numbers of *Ceratium* sp. and *Peridinium* sp. occurred together with the winged *Dinophysis* sp. The feature of particular interest was the occurrence of a number of parasitic dinoflagellates originally attached to the diatom *Rhizosolenia* whose empty frustules could be seen. These egg-shaped creatures lack the armoured shell, the flagellar grooves and flagella of the free living forms and penetrate the diatom by means of rhizoids arising from a short stalk. They resemble some organisms recorded by Paulsen and Ostenfeld from E. Greenland, Danish, and Atlantic plankton in 1910 *et seq.*, and named first *Apodinium chaetoceratis* and later *Paulsenella chaetoceratis*. They are probably identical with a creature described by Haeckel in 1871 as *Protomonas huxleyi* and later regarded as a chytrid.

These descriptions are very incomplete and the life history of the organism is unknown, but the creatures are clearly recognizable as dinoflagellates by their nuclear structure, attachment, and divisions. There is no previous record of organisms of this type occurring in such large numbers, though dinoflagellates do occur as external and internal parasites of planktonic animals, e.g. Copepoda, Tunicata, Radiolaria and other Dinoflagellata, and also of fish.

(*c*) Mrs. L. M. Dowson, B.Sc., exhibited some Radiolaria which had been collected by the R.R.S. *William Scoresby* on her cruise in the Benguela

Current in 1950. Among these were the skeletons of *Sphaerocapsida* sp. (1000–750 m.), *Heliodiscus* sp. (750–500 m.) and *Aulacantha* sp. (*c.* 500 m.). A specimen of *Cytocladus* sp. from off the Azores (500 m.), with some of the calymma and central capsule still intact and several surface Radiolaria from the Mediterranean, which were completely intact, were also shown for comparison. Photographs of the living animals, drawings and notes explained the exhibit.

COMMONWEALTH INSTITUTE OF ENTOMOLOGY. Immigrant termites. [Shown by Mr. W. V. Harris.]

The Isoptera are mainly tropical insects and none is indigenous to the British Isles though there are two species of termites in Southern Europe. Certain Nearctic termites live under climatic conditions similar to those prevailing here, and their establishment would not be impossible. They are restricted to the subfamilies in which digestion of wood is aided by intestinal protozoa. *Reticulitermes flavipes* (Koll.), from the eastern United States, has established itself in Hamburg during the present century.

Recently, two North American termites have been found in timber imported into this country, viz. :

Zootermopsis angusticullis (Hagen), in Douglas fir.
Kalotermes sp. nr. *jouteli* Banks in Lignum Vitae.

The following species are exhibited in laboratory cultures :—

Kalotermes sp. nr. *jouteli* from Santo Domingo.
Cryptotermes dudleyi Banks from Kenya.
Neotermes sp. from Uganda.

Damaged woodwork from buildings in Hamburg and specimens of *Reticulitermes flavipes* were also shown.

BIRKBECK COLLEGE, UNIVERSITY OF LONDON. A genus of Cretaceous pine-cones. [Shown by Dr. K. L. Alvin.]

The demonstration aimed at presenting the general characters of a newly recognized type of fossil Pinaceous cone (*Pseudoaraucaria* Fliche) from rocks of Cretaceous age in France, Belgium and England.

The genus was erected in 1896 for a group of fossil cones which were at the time believed to occupy a systematic position between the Pinaceae and the Araucariaceae. These cones, together with some others having a similar type of organization, have recently been re-investigated in some detail. The cone-type has been recognized as being distinctly Pinaceous ; but it is different from any living member of the family. Its chief distinguishing characters are :— (*a*) The sharp differentiation of the scale into a lower, horizontal, seed-bearing part, and an upper, almost vertical, laminate portion ; (*b*) the deeply embedded position of the seeds which are separated by a massive ridge of scale tissue ; (*c*) the presence of a usually extensive cushion of soft tissue at the base of the seed which, it is suggested, may represent the sterile part of the megasporophyll in the seed-scale complex.

Mr. H. I. MATTHEWS, O.B.E., M.C., and Dr. J. D. H. WISEMAN. Coccolithophoridae (Minute marine algae) in deep-sea deposits.

The Coccolithophorids, a group of the Chrysophyta, occur in great abundance in the upper layer of the sea. Because of their small size (10–60 μ.), they normally pass through plankton nets.

Their soft parts are protected by coccoliths or rhabdoliths, calcareous plates a few microns in diameter.

These plates form a large proportion of the finer grades of some deep-sea

deposits and are found in certain geological formations, e.g. the Chalk. Those in deep-sea deposits were first described by T. H. Huxley in a letter to the *Hydrographer* in 1857.

The delicate structure of the Coccolithophorids is revealed by the electron microscope.

The micrographs exhibited were taken in the Applied Physical Chemistry Laboratory of the Imperial College, the microscope used being of the EM3 type made by Messrs. Metropolitan-Vickers.

The deposits were mounted, either dry or from aqueous suspension, on carbon or formvar films.

The exhibits included stereoscopic views of several Coccoliths and Rhabdoliths, and photographs of Calciosolenids and Rhabdoliths and of *Coccolithus huxleyi* (Lohm) Kemptn., *Coccolithus tenuis* Kemptn., *Cyclococcolithus* sp., *Gephyrocapsa oceanica* Kemptn., *Syracosphaera molischi* Schill and *Syracosphaera pulchra* Lohm., all from deep-sea deposits; and of *Syracosphaera huxleyi* from a plankton culture.

Some of the specimens of *Coccolithus huxleyi* of which micrographs were shown were from the sediments collected by H.M.S. *Cyclops* in 1857 and examined by Huxley.

Royal Horticultural Society. Plant hunting in Nepal. [Shown by the Director, Royal Horticultural Society's Gardens, Wisley.]

British Museum (Natural History), Department of Zoology. A Hermaphrodite lobster. [Shown by Dr. I. Gordon.]

A specimen of the common lobster, from Seahouses, Northumberland, is female on the right side, male on the left side. Although the secondary sexual characters are male on the left side, there is no male sexual opening. The thelycum or sperm receptacle is abnormal in that the left half is small: but the specimen probably functioned as a female with one ovary. Colour was normal; occasionally in a hermaphrodite the animal has the colour different on the two sides of the body.

John Innes Horticultural Institution. Plasmagene inheritance in the cultivated strawberry. [Shown by Mr. Watkin Williams.]

A pictorial demonstration was given of cytoplasmic interactions in the cultivated strawberry leading to abnormality in the chloroplasts. The condition is transmitted through the sex cells and is dependent upon the differential multiplication of units in the cytoplasm having the nature of plasmagenes.

Royal Botanic Gardens, Kew. New species of grasses. [Shown by Mr. C. E. Hubbard, O.B.E.]

Rockall and its Natural History. [Shown by Mr. James Fisher, Miss Y. M. Chamberlain and others.]

Royal Botanic Gardens, Kew. Paintings prepared for future numbers of the *Botanical Magazine* (Royal Horticultural Society). [Shown by Dr. W. B. Turrill, O.B.E., and Mr. J. R. Sealy.]

Zoological Society of London. Some interesting animals from the British Guiana Collection, 1955. (Collected for the Zoological Society by Mr. J. W. Lester, F.L.S., and Overseer H. Vinall.) [Shown by Mr. J. J. Yealland and Mr. A. R. Lanworn.]

A number of animals collected on the recent Joint Zoological Society and B.B.C. Expedition to British Guiana were shown. Among the mammals were a

young Brazilian Tapir (*Tapirus terrestris*), and a Capybara (*Hydrochoerus hydrochoeris*). The birds include a Cock-of-the-Rock (*Rupicola rupicola*), a Red-fronted Woodpecker (*Melanerpes rubrifrons*), a Short-winged Burrowing Owl (*Speotyto cunicularia brachyptera*). A small specimen (6 ft.) of the Anaconda (*Eunectes murinus*) represents a species which is said to rival in size the Reticulated Pythons when fully grown. There was also a specimen of a Burrowing Lizard (*Amphisbaena*), a Surinam Toad (*Pipa pipa*) and a bird-eating spider (*Avicularia*).

British Museum (Natural History), Department of Geology. A cast of the Swanscombe Skull. [Shown by Dr. K. P. Oakley.]

A cast of the Swanscombe Skull, including the right parietal bone discovered by Mr. B. O. Wymer and family, and Mr. Adrian Gibson, on 30 July 1955, was exhibited together with Acheulian implements and fragments of charcoal from the same layer.

The Swanscombe Skull is the oldest human braincase in Europe, probably about 250,000 years old. That the bones are contemporary with the associated remains of interglacial fauna (e.g. *Elephas antiquus, Dama clactoniana*) has been confirmed by fluorine, nitrogen and radio-activity tests.

In so far as it is preserved, the Swanscombe Skull cannot be distinguished with any certainty from some primitive forms of modern man. It is not of the specialized Neanderthal type (which is much later) ; but the frontal bone which still awaits discovery may well have been prominent as in the Steinheim skull found in slightly later deposits near Stuttgart.

British Museum (Natural History), Department of Geology. Skulls of the extinct ground sloths *Mylodon* and *Scelidotherium*. [Shown by Dr. A. Tindell Hopwood.]

Ground sloths appear to have survived in South America until a comparatively short time ago. The skull of *Mylodon* was found in a dry cavern overlooking Last Hope Inlet, S. Patagonia, and that of *Scelidotherium* in the alluvial deposits of Tamarugal, Tarapaca Province, Chile. The bone of both skulls is perfectly fresh, and some of the soft tissues of *Mylodon* are preserved.

Geological Survey and Museum, London. Rock specimens collected from Rockall, September 1955. [Shown by Dr. P. A. Sabine.]

The specimens exhibited were collected during the landing by helicopter from H.M.S. *Vidal* on 18 September 1955.

The interest of geologists in Rockall has been considerable since it was discovered towards the close of the last century that the island was formed of a very unusual variety of soda-granite. In 1896, observers on an Irish ship, from which no landing proved possible, reported that the lower part of the island was stratified, composed of sediments or volcanic tuffs, and the upper part was igneous rock. Three small specimens of the igneous rock, collected during expeditions in 1811 and 1862 were brought together after the Irish venture and were studied by Professor J. W. Judd, who gave to one dark variety, composed of quartz, aegirine and feldspar, the name " rockallite". He thought this part of a great sheet which had formerly overlain the stratified base. Chemical analysis later showed this rock to be very rich in zirconia and the rare earth ceria.

Following a French expedition in 1921, the whole conception of the geology changed. No sediments or tuffs were present : the appearance of stratification was due to the presence of veins of the dark " rockallite' ' in a lighter variety of soda-granite which made up most of the island. Nevertheless, this lighter

variety was in itself of great interest and on examination by Professor A. Lacroix was found to contain the rare zirconosilicate mineral, elpidite.

The observations of Mr. James Fisher, who collected the specimens exhibited, have added to the knowledge of the geology of the island, including the distribution of veins of " rockallite ". It is hoped that investigations now in progress of the specimens he collected will resolve some of the mineralogical questions including the nature and distribution of the rare elements and minerals present.

East Malling Research Station. The balance of predators and phytophagous mites in the orchard.

The exhibit showed specimens of the more important phytophagous mites and their predators at various stages of their life history. Of the three mites that may cause damage to fruit trees, only the Fruit Tree Red Spider Mite (*Metatetranychus ulmi* (Koch)) is an economic problem. This mite was shown in its active stages, feeding on leaves, and also in the dormant winter egg stage on the bark as it occurs outdoors at this time of the year. *Tetranychus telarius* L. and *Bryobia praetiosa* Koch, that are less abundant in orchards, were also shown.

Forty species of predacious insects are known to feed on the mites, and of these a number of Mirid bugs were shown, the most important being *Blepharidopterus angulatus* (Fall.), the Black-kneed Capsid. This was illustrated in all its stages. In addition Anthocorid bugs, three families of Neuroptera, and Coccinellidae were shown, together with brief notes on their habits and life-cycle.

A number of predacious mite species also feed on phytophagous mites, of which the most important are several species, mostly of the genus *Typhlodromus*, belonging to the family Laelaptidae. *Typhlodromus tiliae* Oudms. was shown in the adult female stage in which it normally hibernates throughout the winter. Various true spiders also feed on mites occasionally, as part of a varied diet, and a few representatives of some of the families that frequent orchards were shown.

In addition, the exhibit included records of relative numbers of predators and mites in various types of orchard, illustrating that whereas the unsprayed trees had many predators and few mites, the application of certain spray materials caused the predators to become less abundant and phytophagous mites more numerous.

Dr. D. M. Kermack, Dr. K. A. Kermack and Mrs. F. Mussett. New discoveries of Mesozoic Mammals in South Wales.

The exhibit showed new discoveries of mesozoic mammals made recently in South Wales. They were found in fissures in the Carboniferous Limestone. The age of the mammals is at the latest Upper Triassic or basal Jurassic, as after this time the land in which the mammals lived was drowned by the sea.

Examples are exhibited of two of these mammals ; one of them is a member of the order Triconodonta, which is represented in the fissures by abundant material, comprising the dissociated remains of many thousands of individuals. The other is a member of the order Symmetrodonta, and is known only from isolated teeth. The material suggests that the affinities of the Triconodonta lie with the monotremes.

Until the discovery of the Pant Quarry triconodont the mesozoic mammals were known by little more than isolated teeth and jaws, yet by the end of the Mesozoic era the Mammalia had passed through more than half of their known existence. In the new find other bones of the skeleton are abundant, and a clear picture of the animal is beginning to appear. Already the quantities of this

triconodont prepared exceed that of the total of all the other mesozoic mammal material so far collected in the rest of the world.

Mr. D. W. Tucker, F.L.S. A series of Ecuador postage stamps commemorating the Darwin/Beagle visit to the Galapagos Islands.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 19 January 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 17 November 1955, having been circulated, were taken as read, and confirmed.

The President reported that Mr. H. N. Ridley, C.M.G., F.R.S,, had expressed his grateful thanks for the Society's Congratulatory Message sent on his One-hundredth Birthday, and that a Congratulatory Message had also been sent to our senior Fellow, Mr. William Stone, on his Ninety-ninth Birthday on 14 January 1956.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. G. S. Carter, Dr. L. Chalk, Dr. J. G. Cockburn, Dr. R. E. Holttum, Dr. A. E. Porsild, Mr. H. Stansfield, Professor Randolph W. Taylor, F.M.L.S., The John Innes Horticultural Institution and the Botanic Gardens, Singapore.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Ronald Goulding Atkinson, Dr. Peter Harold Lowings, Mr. Thomas Jennings Wallace, T.D., B.Sc., and Mr. Trevor John Longhurst, B.Sc.

The President reported the following deaths: —Professor Dr. Carl Jorgen Wesenberg-Lund, Foreign Member, Antony Gepp, F.L.S., Sir Arthur (George) Tansley, F.R.S., Fellow, and Professor Patrick Alfred Buxton, C.M.G., F.R.S. (Linnean Medallist 1953).

The following communications were read and discussed :—

Dr. R. W. Butcher, F.L.S. Marine micro-flagellates—a long over-looked ecological group. (Discussed by Dr. Nellie Carter, Prof. F. W. Jane, Mr. R. Ross, Dr. E. M. Delf and Dr. H. A. Cole ; Dr. Butcher replied).

Abstract—

Whilst the larger and more robust members of the marine plankton have been studied for many years, those under a size of about 15 μ have been largely overlooked. This is chiefly because of their extreme delicacy since most of them are destroyed or distorted by any fixative and many do not even remain alive long in a flask or a stoppered bottle.

Their importance as food for larval oysters has been demonstrated by Cole, Gross, Parke and others, and when Cole and Knight-Jones made some numerical estimations of their quantities at Conway, it was found that they occurred frequently in great abundance and that the majority were undescribed. Only Dr. N. Carter in this country had made collections and in a single paper she described 23 new species. Intensified study of these small organisms in coastal waters and estuaries has shown them to be of universal occurrence and extremely varied, and there are numerous representatives of all the recognized algal groups, the Chrysomonads and Cryptomonads being particularly varied.

In view of their importance as the particulate food of larval forms of many marine animals a systematic account of these organisms is urgent and material is now being gathered for this purpose.

The organisms are grown as unialgal culture in an enriched seawater medium which provides them in sufficient abundance for study. Probably one is obtaining only the more adaptable of the organisms which occur but even so a year's collection has yielded some 500 apparently different strains.

The size limit for this study has been set at 20 μ and organisms of 1–3 μ are quite abundant and represent every group.

Of the Chlorophyceae the genera *Platymonas* with 4 flagella and *Dunaliella* (2 flagella) are the most frequently occurring—the freshwater *Chlamydomonas* is rare.

Interesting organisms with 8 flagella are also seen. A minute number of the Chlorellaceae of 2 μ diameter is frequent. Among the Chrysomonadineae the most interesting are the organisms with a flagellum-like structure (in addition to the normal one or two flagella) which has a different function and has recently been described by Dr. Parke and Professor I. Manton as a Haptothrix. Such organisms are widespread. Cryptomonadineae are noted for their abundance at times and the variety of the coloration; brown, red, blue, green and yellow species have been collected.

Miss P. Lamplugh Robinson (Visitor). The Mesozoic fissures of the Bristol Channel area and their vertebrate faunas. (Discussed by Prof. D. M. S. Watson, Prof. Tom Harris, Prof. S. E. Hollingworth, Dr. K. A. Kermack, Dr. A. d'A. Bellairs and Mr. R. J. G. Savage; Miss Robinson replied.) **[Printed in full in *Journal Zoology* No. 291.]**

Abstract—

Fissure-fillings found in Glamorgan, Gloucestershire, and Somerset, have provided a rich yield of Mesozoic terrestrial vertebrates. Mammals and mammal-like reptiles, of Rhaetic or Lower Jurassic age, and obtained from submarine fissures, have already been described by Kühne and Parrington. A fauna of nineteen pre-Rhaetic Sauropsid reptiles has been discovered; their age was discussed, and the nature of the fissures in which they were found. These fissures, continental in origin, represent underground watercourses which probably silted up late in Triassic times. The physical background of the new fauna, which can be sketched from geological evidence, suggests an interesting feature common to these reptiles. Two reptiles were described; one has a most unusual dentition, of a kind more usually associated with mammals than with sauropsid reptiles.

The following papers were read in title :—

Studies in the systematic anatomy of the Zingiberaceae. By P. B. Tomlinson. (Communicated by Dr. C. R. Metcalfe, F.L.S.) **[Printed in *Journal, Botany*, No. 361.]**

The Marine Hemiptera of the Monte Bello Islands, with descriptions of some allied species. By W. E. China, M.A., Sc.D. (Communicated by the Zoological Secretary.) **[Printed in *Journal, Zoology*, No. 291.]**

Cytotaxonomy of *Spirogyra* 1. *S. submargaritata, S. subechinata* and *S. britannica*. By M. B. E. Godward, F.L.S. **[Printed in *Journal, Botany* No. 361.]**

A further note on Edward Morgan and the Westminster Physic Garden. By R. H. Jeffers, F.L.S. **[Printed in full on p. 96.]**

On certain planktonic palmelloid green algae. By J. W. G. Lund, F.L.S. **[Printed in *Journal, Botany*, No. 361.]**

The Linnaean species of Carabid beetles. By Carl H. Lindroth. (Communicated by the Zoological Secretary.) **[Printed in *Journal, Zoology*, No. 291.]**

Journey to Northern Ethiopia (Simien), 1952–53. Coleoptera, Carabidae. By P. Basilewsky. (Communicated by Dr. Hugh Scott, F.R.S., F.L.S.) **[Printed in *Journal, Zoology*, No. 290.]**

Some morphological and teratological observations in the flower of *Eugenia malaccensis* Linn. By D. M. A. Jayaweera, F.L.S. **[Printed in *Journal, Botany*, No. 362.]**

Cyto-taxonomic studies of the Gold Coast species of *Commelina* L. By J. K. Morton. (Communicated by the Botanical Secretary.) **[Printed in *Journal, Botany*, No. 361.]**

PROCEEDINGS OF THE GENERAL MEETING HELD ON 2 February 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 19 January 1956, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Dr. Hideo Moriyama, Dr. T. E. Wallis, Miss E. M. Stephenson, Prof. C. T. Ingold, the Trustees of the British Museum and Mr. George T. Atkinson.

The following communications were read and discussed:—

Mr. A. H. G. Alston, F.L.S. On a Linnaean Herbarium in Paris. (Discussed by Mr. R. Ross and Dr. John Ramsbottom; Mr. Alston replied.) **[Printed in full on p. 102.]**

Dr. I. Gordon, F.L.S. On the systematic position of certain higher Crustacea.

Abstract—

Gurney, in his Ray Society Monograph "Larvae of Decapod Crustacea" 1942, p. 11, mentioned four main difficulties in framing a satisfactory classification for the Decapoda. Of these, two were discussed. (i) Relation of the Euphausiacea to the Decapoda: As regards larval development and adult morphology the Euphausiacea, krill or whale feed, appear to be most closely related to the primitive Decapods, the Penaeidea, and especially to the Sergestids. (ii) Relation of the Dromiacea and Raninids to the Brachyura: The heterogeneous assemblage known as the Anomura includes various crab-like forms, such as Porcellanids, Hippids, *Lithodes*, and a sharp division between it and the Brachyura seems at present impracticable. The vast majority of the Brachyura have the female genital openings sternal, not coxal, and the sperm receptacle is a diverticulum of the vagina; fertilization of the ova is thus internal. A number of crab-like forms, sometimes placed in the Brachyura, sometimes in the Anomura, prove to have special spermathecae or sperm receptacles in the sternum, whereas the genital openings are coxal. In these fertilization is external as in most Decapods and the presence of specialized spermathecae would seem to point to closer affinities with some of the Macrura than has hitherto been suspected.

Mr. H. E. Goto, F.L.S. Some problems in the systematics of Collembola. (Discussed by the Zoological Secretary, Dr. J. P. Harding, Mr. D. W. Tucker and the President; Mr. Goto replied.)

Abstract—

Some confusion has arisen in the systematics of Collembola because, in the majority of cases, the juvenile stages cannot be recognized as such by external characters and the slight differences between successive instars are undescribed. As a result "new species" have been described, often inadequately, which have been found to be immature specimens of already known species. In addition our knowledge of the morphological variation within the species is such that abnormal specimens could quite easily be misidentified or even described as species new to science. Two cases, based on the results of breeding experiments, were described and illustrated to demonstrate these points. A demonstration of culture methods was shown.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 16 February 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 2 February 1956, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—The National Museum of Wales, Cardiff and the Museum and Art Gallery, Durban.

Mr. Edward Joseph Shellard, B.Pharm., and Miss June Rosemary Rees, M.Sc., signed the Obligation in the Roll and Charter Book, and were admitted Fellows.

The President reported the death of Professor George Howard Parker, Foreign Member.

The President reminded Fellows that proposals for Officers and New Members of Council under Bye-Law, Chap. 8, Sect. 2, and for Foreign Members and Associates *honoris causa*, should be forwarded to the General Secretary not later than 6 April 1956.

The following communications were read and discussed:—

Dr. W. A. Sledge. Observations on the fern flora of Ceylon. (Discussed by Dr. R. E. Holttum, Mr. A. H. G. Alston and Dr. W. B. Turrill; Dr. Sledge replied.)

Abstract—

The need for a revised account of the fern flora of Ceylon became apparent when working out material collected—primarily for cytological purposes—during a six weeks' collecting visit in the winter of 1950–51. A second visit of three months duration was made in 1953–54. The great majority of the species are confined to the wet zone centred round the mountainous region in the southern and south-western part of the island. Approximately 13 per cent of the ferns are endemic as compared with 29 per cent of the flowering plants. Of the non-endemic species about 10 per cent are common to Malaya and Indonesia and do not occur in India. The bearing of cytological observations and field studies upon the taxonomic treatment of certain species and species groups were discussed.

Dr. P. van Royen gave an account of the Netherlands Botanical Expedition 1954/1955 to New Guinea, illustrated with coloured slides and films.

Abstract—

The vegetation of New Guinea especially of the coastal regions has not been explored very thoroughly. With the object of extending the knowledge of these regions the National Herbarium in Leyden sent an expedition to New Guinea in February 1954 which lasted till March 1955.

Extensive explorations were made which included trips to the Australian part of New Guinea in an area never previously visited by botanists. Among these were the interior of the "Vogelkop" Peninsula and the regions around Lake Wam and Fly River. Trips made by eighteenth and nineteenth century botanists were retraced as in many cases their collections are lost to science. These included trips to the island of Waigeo and the Cycloop Mountains. From these trips extensive collections of dried and living plants were collected. Colour-slides and two colour films were made from which a selection was shown.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 1 March 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 16 February 1956, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Mr. P. Hunter-Jones and the Imperial Forestry Institute, Oxford.

Dr. Reginald Smithson Julian Hawes and Dr. John Colhoun signed the Obligation in the Roll and Charter Book, and were admitted Fellows.

The President reported the deaths of Dr. Elmer Drew Merrill, Foreign Member and Dr. Albert Henry Beaumont Kirkman, Fellow.

Certificates of Recommendation for Election to Fellowship were read for the first time in favour of:—Robert Stephen Adamson, M.A., D.Sc., Peter Kenneth Charles Austwick, B.Sc., Rev. Herbert Edwin James Biggs, Angus Herdman Booth, B.A., Gwilym Owen Evans, M.Sc., Ph.D., Robert Stephen George, N. K. Gupta, M.Sc., Ph.D., R. Harvey, B.Sc., A.L.S., William Howell, Malcolm Cyril Jacobs, B.Sc., John Dudley Romer, Henry Gwynne Vevers, M.B.E., M.A., D.Phil., and Frank White, M.A.

The following communications were read and discussed:—

Dr. S. Brian Kendall. Host-parasite relationships between Liver-flukes and *Lymnaeidae*. (Discussed by Dr. C. A. Wright and Prof. B. G. Peters; Dr. Kendall replied.)

Abstract—

(1) Under experimental conditions, snails collected in the North-West Frontier Province of Pakistan and provisionally identified as different forms of the race *rufescens* of *Lymnaea auricularia* sensu lato, proved resistant to infection with a West African strain of *Fasciola gigantica*. (2) By contrast, there was a relatively high, although variable, degree of susceptibility to infection with miracidia from a Pakistan strain of fluke. (3) Species discrimination in these *Lymnaeidae* and in the genus *Fasciola* were discussed.

Dr. L. P. Joyner and Dr. S. Brian Kendall. Potentiation of the coccidiostatic activity of sulphonamides by pyrimethamine. (Discussed by the President and Zoological Secretary; Dr. Joyner replied.)

Abstract—

Synergism between two drugs is a new principle in the chemotherapy of *Eimeria tenella* and experiments illustrating some of the properties of combinations of pyrimethamine and sulphadimidine were described.

The biology of *Eimeria tenella* in relation to drug action was discussed. The experimental results obtained with combinations of varying doses of pyrimethamine and sulphadimidine support previous hypotheses concerning physiological differences between different developmental stages of the parasite.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 15 March 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 1 March 1956, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. P. J. Greenway, O.B.E., Dr. B. Verdcourt, the East Africa Agricultural and Forestry Research Organization, Kikuyu, and Dr. H. Hamshaw Thomas, M.B.E., F.R.S.

The President reported the deaths of J. Pryce-Jones and Frederick Kirkwood Makins, Fellows of the Society.

Certificates of recommendation for election to Fellowship in favour of those candidates whose names were printed in the report of the Meeting held on 1 March 1956 were read for the second time and a certificate of recommendation for election to ordinary Associateship was read for the first time in favour of :—Derek George Campion, B.Sc.

The General Secretary read the relevant section of the Charters dealing with the Council's powers to establish or amend the Bye-Laws, subject to their confirmation by the Fellows by means of a Ballot after their third reading.

The President read for the first time the proposed Alteration in the Bye-Laws relating to the Annual Contribution paid by Fellows, viz. :—

That Chapter 2, Section 2, be re-worded to read as follows :

> Every Fellow shall before he is admitted pay the First Annual Contribution of not less than five pounds, and he shall pay the like sum annually in advance on each successive 24th day of May so long as he shall continue a Fellow ; provided, however, that Fellows elected between the 1st day of March and the 24th day of May in any year shall not be liable for a second Annual Contribution until the 24th day of May in the year following that in which they were elected ; and provided, moreover, that any Fellow not in arrears with his Annual Contribution may at any time compound for all future Annual Contributions by paying a Composition Fee according to the table set out in the Appendix. Every Fellow desiring to compound must satisfy the Council as to his age.

The President stated that the following amendments to the proposed alteration to the Bye-Laws had been received and said that the Council after due consideration were unable to accept them.

Amendment 1. In the second line, delete the words " not less than ".

Amendment 2. After " elected " ; in the 7th line, add :—
" provided, however, that Fellows who enter into a Deed of Covenant to pay an Annual Contribution shall so pay four pounds instead of five pounds ; "

The TREASURER explained the necessity for increasing the Annual Contribution paid by Fellows and the reasons for the Council's non-acceptance of the proposed amendments.

The following communications by Members of the Staff of the Marine Biological Association, Plymouth, were read and discussed :—

Dr. L. H. N. COOPER. Oceanic circulation and life in shallow seas. (Discussed by Dr. Anna Bidder and Dr. N. A. Mackintosh ; Dr. Cooper replied.)

Abstract—

In the last thirty years there have been large qualitative and quantitative changes in the biological productivity of the English Channel and of Californian, and Japanese waters. A group of hypotheses was described by which fluctuations in the climate of the Arctic may influence the chemistry and hence the productivity of temperate shallow seas. Physical events in the deep Atlantic and Pacific Oceans provide the connecting links.

Mr. G. R. FORSTER. Studies on a marine rock fauna.

Abstract—

The best method of studying the fauna of submerged rocks is with self-contained diving apparatus. Samples can be easily collected for identification, and observations can be made over a wide area to determine the relative abundance of different forms. The technique used and results obtained from diving in the vicinity of Plymouth were described and illustrated with slides.

Dr. D. B. CARLISLE. Endocrinology of marine Crustacea.

Abstract—

Up to 1953 it was generally believed that there was only a single hormone in Crustaceans, but during the last three years a number of additional hormones have been discovered, so that now seven have been characterized with certainty, and there are other effects which may be due to these same hormones or may be due to independent hormones : moulting, colour change, sexual development and various biochemical processes have been shown to be under endocrine control.

Dr. B. C. ABBOTT. Some lines of physiological research.

Abstract—

A number of research projects are being undertaken of a biophysical nature including accumulation of certain trace elements by Ascidians ; an investigation into toxicity of a particular Dinoflagellate ; some experiments into the energetics of smooth muscles.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 19 April 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 15 March 1956, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. A. V. Bogdan, Mr. C. McCann, Mr. H. Moriyama, Rev. H. Santapau, S.J., Mr. S. Gordon Smith and Dr. B. M. Hobby.

The following signed the Obligation in the Roll and Charter Book, and were admitted as Fellows :—Mr. Frank Nigel Hepper, B.Sc., Mr. Basil Hubert Harley, B.A., and Mr. Donald Eric Caulton, B.Sc.

The President reported the death of Frederick James Fitzmaurice Barrington, Fellow of the Society.

The proposed Alteration in the Bye-Laws relating to the Annual Contribution paid by Fellows was read for the second time.

In reply to a request by Mr. A. A. Bullock, F.L.S., that the reading of the proposed alteration to the Bye-Laws increasing the Annual Contribution paid by Fellows be deferred for further consideration, the President explained that the proposed Alteration having been approved by the Council, the procedure outlined in the Society's Charter must be followed, viz., that any Bye-Law or Alteration established by the Council shall be read at two successive Meetings and that no such Bye-Law or Alteration to an existing Bye-Law shall be binding on the Society until the same shall have been confirmed by Ballot by the Fellows at large ; such Ballot to take place at the ensuing meeting next after the two successive readings.

Certificates of recommendation for election to membership were read for the first time in favour of the following :—*Foreign Members* :—Professor Irving Widmer Bailey, Sc.D., Cambridge, Mass., U.S.A., Dr. Anton Brünn, Copenhagen, Professor J. A. Efremov, U.S.S.R., Professor Karl von Frisch, Munich, Professor Richard Harder, Göttingen, Dr. Bernhard Rensch, Germany and Professor Ø. Winge, Copenhagen. *Fellows* :—Debendra Bijoy Deb, M.A., D.Phil., Charles Burford Goodhart, M.A., Ph.D., Dennis Roy Green, B.Sc., Mrs. Anna Nellie Griffith, M.A., Peter Raymond Slater Hunt, Premnath Kachroo, M.Sc., Ph.D., Donald Leatherdale, John Lewis, B.Sc., Sir Giles Rolls Loder, Bart., M.A., Sidney John Relph, B.Pharm., Tem Smitinand, Kenneth Robert Sporne, M.A., Ph.D., John Nevison Wilson, B.A., and Elwood Curtin Zimmerman, B.Sc., Ph.D.

The following candidates for Fellowship and Ordinary Associateship were balloted for and elected; Fellows :—Robert Stephen Adamson, M.A., D.Sc., Peter Kenneth Charles Austwick, B.Sc., Rev. Herbert Edwin James Biggs, Angus Herdman Booth, B.A., Gwilym Owen Evans, M.Sc., Ph.D., Robert Stephen George, N. K. Gupta, M.Sc., Ph.D., R. Harvey, B.Sc., A.L.S., William Howell, Malcolm Cyril Jacobs, B.Sc., John Dudley Romer, Henry Gwynne Vevers, M.B.E., M.A., D.Phil., and Frank White, M.A.; Ordinary Associate :—Derek George Campion, B.Sc.

The following communications on the Biological Work at the Forest Products Research Laboratory, Princes Risborough, were read and discussed :

Dr. F. Y. Henderson, C.B.E. Introductory remarks.

Dr. E. W. J. Phillips. The wood Structure Section. (Discussed by Mr. R. W. J. Keay, Prof. F. W. Jane, Mr. P. R. Bell and Dr. C. R. Metcalfe ; Dr. Phillips replied.)

Mr. J. G. Savory. The Mycology Section. (Discussed by Dr. J. Ramsbottom, Dr. W. M. Page, Dr. R. Melville, Prof. F. W. Jane, Mr. R. R. Davies and Dr. C. R. Metcalfe ; Mr. Savory replied.)

Mr. J. D. Bletchly. Some aspects of the work of the Entomology Section. (Discussed by Dr. C. R. Metcalfe, Dr. B. M. Hobby, Mr. W. E. Hollows, and Mr. W. T. Saxton ; Mr. Bletchly replied.)

[Papers printed in full on p. 103.]

The President announced that Mr. W. S. Warton the Society's Librarian, was retiring in June next after 40 years' service with the Society and invited Fellows who so wished to forward contributions to a Testimonial Fund being raised on his behalf.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 3 May 1956

Dr. H. Hamshaw Thomas, M.B.E., F.R.S., President, in the Chair.

Only fellows attended the Meeting for items 1 to 4 of the printed Agenda.

After paragraph six of the circulated Proceedings of the General Meeting, held on Thursday, 19 April 1956, had been amended to read as follows, the Proceedings were confirmed.

Paragraph six amended to read :—

> " In reply to a request by Mr. A. A. Bullock, F.L.S., that time be given before the Ballot to debate the proposed Alteration to the Bye-Laws increasing the Annual Contribution paid by Fellows, the President explained that the proposed Alteration having been approved by the Council, the procedure outlined in the Society's Charter must be followed, viz., that any Bye-Law or Alteration established by the Council shall be read at two successive meetings and that no such Bye-Law or Alteration to an existing Bye-Law shall be binding on the Society until the same shall have been confirmed by Ballot by the Fellows at large ; such Ballot to take place at the ensuing meeting next after the two successive readings. The President stated, however, that whilst no amendments could be made, an opportunity would be given to debate the proposed alteration before the Ballot."

The following were thanked for gifts made to the Library since the last Meeting :—Dr. L. Chalk, Mr. L. Webster, the Hope Department of Entomology, University Museum, Oxford, the family of Herman Augustus Spoehr, Mr. R. S. George and Dr. B. M. Hobby.

The following signed the Obligation in the Roll and Charter Book, and were admitted as Fellows :—Professor Robert Stephen Adamson, D.Sc., Dr. N. K. Gupta, M.Sc., Mr. R. Harvey, B.Sc., Mr. William Howell, Mr. John Francis Levy, B.Sc., and Dr. Henry Gwynne Vevers, M.B.E., M.A.

The President appointed Dr. W. B. Turrill, O.B.E., and Dr. B. M. Hobby as Scrutineers of the Ballot.

The President gave some reasons why the Council considered it necessary to increase the Annual Contribution paid by Fellows and invited Fellows to express their views on the proposed Alteration, and the following Discussion took place :—

Mr. A. A. Bullock referred to the gap in the Society's Accounts and said that he did not think the proposed Alteration would fill it. Withdrawals from Fellowship due to the increase would reduce the estimated additional income.

A retirement of Staff would add another £100, in augmenting a Pension annuity, to the Society's liabilities. He asked Fellows to refer the whole matter back to Council, who in his opinion had not given sufficient consideration to the subject or information to the Fellows.

Dr. R. Melville supported Mr. Bullock's contentions and added that he did not think that the Society was an economic unit.

The Rt. Hon. The Earl of Cranbrook said he thought it better to increase the Annual Contributions little by little if it was found necessary rather than to make a sudden large increase.

The Treasurer said that the Covenant Scheme already assisted materially to close the gap and he was loath to do anything, such as to lower the Annual Contribution for those who entered into a Deed of Covenant, which might prejudice the continuance of Covenanting for Annual Subscriptions, which existed now largely on sufferance. The Treasurer further said that there was no indication as yet of increased withdrawals from the Society because of the proposed increase and he believed that they would be few in proportion, and that this year there had been more applications to join the Society than in recent years.

Mr. J. B. Gillett said he thought the increase would hit the younger generation much more heavily than the older and the Society could only live by the introduction of new young blood.

The Zoological Secretary said that the financial position of junior members of Universities and Institutions was much more favourable than it had been 25 years ago, and that £5 to-day meant much less than £4 when the Annual Contribution was previously raised in 1920.

Mr. Bullock concluded by saying that he thought that the only salvation of the Society lay in a large increase in the Fellowship, if necessary to 2000, with a comparatively low Annual Contribution.

At the end of the Discussion the Ballot for the proposed Alteration was taken and after the Scrutineers had counted and reported the number of votes cast, the PRESIDENT announced that the Alteration to the Bye-Laws had been approved by the necessary two-thirds majority :—

That Chapter 2, Section 2, be re-worded to read as follows :—

> Every Fellow shall before he is admitted pay the First Annual Contribution of not less than five pounds, and he shall pay the like sum annually in advance on each successive 24th day of May so long as he shall continue a Fellow ; provided, however, that Fellows elected between the 1st day of March and the 24th day of May in any year shall not be liable for a second Annual Contribution until the 24th day of May in the year following that in which they were elected ; and provided, moreover, that any Fellow not in arrears with his Annual Contribution may at any time compound for all future Annual Contributions by paying a Composition Fee according to the table set out in the Appendix. Every Fellow desiring to compound must satisfy the Council as to his age.

Certificates of recommendation for election to Fellowship and Foreign Membership were read for the second time in favour of those named in the Proceedings of the General Meeting held on 19 April 1956.

The following were elected Auditors of the Treasurer's Accounts for 1955–56 under Chap. 10, Sect. 7 of the Bye-Laws :—

Representing the Council :	Dr. A. TINDELL HOPWOOD, Dr. S. M. MANTON, F.R.S.
Representing the Fellows :	Mrs. F. L. BALFOUR-BROWNE, Dr. W. E. SWINTON.

The following communication was read :—

Dr. J. Rzoska. Journeying down the Nile. Illustrated by a series of coloured and monochrome slides. **[Printed in full on p. 116.]**

PROCEEDINGS OF THE ANNIVERSARY MEETING
24 May 1956

Dr. H. Hamshaw thomas, M.E.B., F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 3 May 1956, having been circulated, were taken as read, and confirmed.

The President reported that he had received a request to publish the figures of the Voting for the Ballot for the Alteration of the Bye-Laws, taken on 3 May 1956. The figures were : 36 in favour and 14 against the proposed Alteration.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. R. E. Holttum, Mr. H. R. Marshall, the Royal Society, London, the Freshwater Biological Laboratory, University of Copenhagen, Instituto de Botanica, São-Paulo and Mr. E. J. H. Corner, F.R.S.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Peter Kenneth Charles Austwick, B.Sc., the Rev. Herbert Edwin James Biggs and Mr. Henry Lindsay Gray Stroyan, M.A.

Candidates for membership were balloted for and elected :—

Fellows.—Debendra Bijoy Deb, M.A., D.Phil., Charles Burford Goodhart, M.A., Ph.D., Dennis Roy Green, B.Sc., Mrs. Anna Nellie Griffith, M.A., Peter Raymond Slater Hunt, Premnath Kachroo, M.Sc., Ph.D., Donald Leatherdale, John Lewis, B.Sc., Sir Giles Rolls Loder, Bart., M.A., Sidney John Relph, B.Pharm., Tem Smitinand, Kenneth Robert Sporne, M.A., Ph.D., John Nevison Wilson, B.A., and Elwood Curtin Zimmerman, B.Sc., Ph.D.

Foreign Members.—Professor Irving Widmer Bailey, Sc.D., Dr. Anton Fr. Bruun, Professor J. A. Efremov, Professor Richard Harder, Professor Bernhard Rensch, Professor Karl von Frisch and Professor Øjvind Winge.

The By-Laws regulating the Election of Council and Officers having been read by the General Secretary, the President declared the Ballot for new Members of Council to be open, and voting began. The President thereafter appointed Dr. J. M. Rowson, Capt. Cyril Diver, C.B., C.B.E., and Mrs. Vera Higgins, V.M.H., as Scrutineers of the Ballot.

PRESENTATION OF LINNEAN GOLD MEDAL

In handing the Linnean Gold Medal to Professor William Henry Lang, F.R.S., the President said:—

Professor William Henry Lang. Since 1888 Linnean Gold Medals have been awarded to botanists and zoologists who have made outstanding contributions to our knowledge of the flora and fauna of the world. In nominating you as the recipient of the Medal this year, the Council wish to show our appreciation of the remarkable work which you have accomplished in displaying to man the flora of an age long past. You have given us concrete evidence of many of the plants of the Early Devonian period, which must be far different in form from anything previously imagined, and which seem to provide links between

the Thallophyta and the Vascular Plants. As we approach the centenary of the publication of *The Origin of Species* your contribution of material evidence of the theory of evolution is of special interest. You have not been content merely to describe these incredibly ancient forms as marks on slabs of rock, but, by your patient and skilful handling of the material, you have revealed much of their structure. When you collaborated with that prince of amateur naturalists, Robert Kidston, you were able to describe the structure of the plants of the Rhynie Chert as completely, in several respects, as if you had been dealing with living species.

We also recall the valuable contributions which you made towards our understanding of the ferns, especially the Ophioglossales, and your solution of the long outstanding morphological problems in the structure of Isoetes.

You began work under the guidance of one of the great British botanists, F. O. Bower, and had the invaluable experience of a visit to the forests of the eastern tropics. You in your turn have exerted on younger botanists a lasting influence far beyond the confines of plant morphology. It gives me particular pleasure in being able to present this medal to one who has so greatly stimulated my own thought and work.

Professor Lang expressed his thanks for the award.

The Financial Report was given by the Treasurer and the Accounts of the Society, duly audited, for the year 1955–56, were laid before the meeting.

On a motion by Dr. John Smart, seconded by Dr. G. S. Carter, the Report and Statement of Accounts were adopted.

TREASURER'S REPORT

Printed copies of the accounts for the financial year which ended on 30 April 1956 are before you. For comparison, the figures for last year are printed in italics on the left-hand side. A Statement has been prepared by the Auditors who certify as to details; the Audit Committee has inspected the books, verified the investments and bank balances and passed the Accounts; the action of the Committee has been confirmed by the Council.

I will briefly go through the accounts and deal with the main items :—

On the Income Side.

Annual Contributions are slightly higher due to more arrears having been received.

Income Tax on Deeds of Covenant at £307 is an improvement on last year and it is hoped that the receipts this coming year will increase still more as the result of further Fellows agreeing to Covenant. These Covenants are a great help to the finances of the Society and it is very much hoped that as many Fellows as possible will sign a Deed of Covenant, and further, that those Fellows who have already signed a Deed for a £4 Annual Contribution will pay now the additional £1 by which the Annual Contribution has been increased.

Interest and Dividends are higher due to the increased Bank Deposit Interest Rate and Investment of Composition Fees.

Composition Fees are greatly increased due to Fellows taking advantage of the Special Composition Fee for Fellows of long-standing who have reached the age of 65.

Publications Sales is a record figure and well above the average receipts.

Of the £1250 *Grant for Publications* received from the Royal Society, £750 is towards the cost of a Monograph on *Berberis* which the Society has accepted

for publication and towards the cost of which the Royal Horticultural Society has promised £250. We are again very grateful to the Royal Society for the allocation of this grant, but you will remember that last year I said that we had been informed that we cannot consider this assistance towards the cost of our publications in the nature of an annual grant.

The £625 from the Percy Sladen Memorial Fund is in respect of Reports of their expedition published in the Society's *Transactions*. Queen Mary College have given a Grant towards the cost of a paper being issued in the *Journal, Botany*.

The Council is going into every item of our expenditure to see where economies may be made. Consideration is being given to reducing the cost of distributing the General Meeting Agenda and Minutes; except for the more frequently-used periodicals, the Library Committee is employing a cheaper binding and in some instances placing the parts between strapped boards.

Transfer from Reserve Funds £2250 from the Reserve for Publications and £500 Auckland University Grant has been transferred to the General Account towards the cost of Publications of which I will speak later.

Fellows Postal Account. This amount represents the balances of deceased Fellows written off.

On the Payment Side.

Electricity, Gas and Fuel. Up a little due to the increased cost of coke.

Furniture and Repairs. The extra expenditure was mainly on the repair of chairs and a new carpet for the Council Room. New carpets have now been laid down in both rooms of the Library.

National Insurance. This is due to an increase in contributions.

Miscellaneous Printing, etc. Are higher than last year. This year they include the General Meeting Agenda cost for 16 Meetings and only 9 Meetings were included last year.

Stockroom Reorganization £174. This was paid to Students during the summer for sorting, repacking, restacking and stocktaking. The stockroom in the basement had suffered much from blast during the war; broken wrappings were causing deterioration, and the lack of order was causing difficulty in finding any particular number required. This is now put in order.

Petty Expenses and Postages. Increase due to recent increase in postage rates.

Publications. As I anticipated last year, this figure is much higher. During the Session just ended we have issued THREE parts of the *Proceedings*. TWO *Journals, Zoology* and ONE *Journal, Botany* and a further number of the *Journal, Botany* is nearing distribution by the Printers. In proof now and which we hope will be issued soon we have *Journal, Zoology* Nos. 289, 290 and 291, *Journal, Botany*, No. 361 and TWO Parts of the *Proceedings*. Payment on account of all the publications mentioned is included in the figure of £4987. To meet this figure it has been necessary to take £2250 from the Reserve for Publications and the Auckland University Grant of £500 has been expended. Publications are now or will be in the near future up to date and all these publications have been paid for. The reserve which I have made in past years was for this especial purpose.

There has been much disappointment in the delays in printing of our publications and the Council is considering how these delays can be speeded up.

The Reserve for publications has now been reduced to £1740 plus £750 for the *Berberis* Monograph.

Salaries, Wages and Pension. This figure is higher than last year due to increases.

General

1954–55 £	RECEIPTS	£ s. d.	1955–56 £ s. d.
	To Balance at 1 May 1955 :—		
	Current Account at Bank	58 18 5	
	Deposit Account at Bank	650 0 0	
	Deposit Account Post Office Savings Bank	87 5 0	
	Cash in hand	14 11 7	
807			810 15 0
60	,, Admission Fees		64 0 0
	,, Arrears of Annual Contributions	146 19 9	
	,, Annual Contributions for year	2770 14 3	
	,, in advance	102 5 0	
2879			3019 19 0
17	,, of Associates		22 0 0
283	,, Income Tax recovered on Deeds of Covenant		307 16 2
44	,, Composition Fees		336 0 0
372	Interest and Dividends (including Income Tax recovered)		418 6 7
119	Post Office Savings Bank Account		122 2 6
	Sales of Publications :—		
	Transactions	195 10 9	
	Journals	612 12 1	
	Proceedings &c.	224 9 3	
886			1032 12 1
	,, Grants in aid of Publications :—		
1000	Royal Society	1250 0 0	
20	*Mr. H. Womersly*	—	
—	Queen Mary College	10 16 0	
—	Mrs. L. Cranwell Smith	3 10 1	
—	Percy Sladen Memorial Fund	625 3 6	
			1889 9 7
168	,, Miscellaneous Receipts		115 3 9
—	,, Fellows' Postal Account		25 1 10
—	,, Transfers from Trust Funds :—		
90	*Hooker Lecture Fund*	—	
89	*Westwood Fund*	—	
	Reserve for Publications	2250 0 0	
	Auckland Univ. Grant (Chapman)	500 0 0	
			2750 0 0
6834			£10913 6 6

Library

		£ s. d.	£ s. d.
174	To Balance at 1 May 1955		91 3 6
79	,, Interest on Investments (including Income Tax recovered)		79 2 8
10	,, Donations : John Innes Horticultural Institution	10 0 0	
21	Imperial Chemical Industries Ltd.	21 0 0	
			31 0 0
500	,, Transfer from General Account		500 0 0
200	,, *Transfer from Library Restoration Fund*		—
984			£701 6 2

Library

		£ s. d.
903	To Balance at 1 May 1955	723 1 8
20	,, Donations : Fellows and Friends	6 5 7
923		£729 7 3

Fellow's Postal

£		£ s. d.
50	To Balance at 1 May 1955	50 4 4
1	,, Deposit	1 3
51		£50 5 7

YEAR ENDED 30 APRIL 1956
Meeting, 24 May 1956)
from 1 *May* 1955 *to* 30 *April* 1956.

Account

1954–55 £	PAYMENTS	£ s. d.	1955–56 £ s. d.
239	By Electricity, Gas and Fuel		255 10 11
79	,, Furniture and Repairs		158 1 10
89	,, National Insurance and Fire Insurance		102 6 7
276	,, Miscellaneous Printing and Stationery and Dispatch		421 10 2
399	,, Petty Expenses and Postages		425 7 2
	,, Publications (including payment on account) :—		
	Printing	4461 13 3	
	Distribution	118 16 8	
	Illustrations	406 12 3	
			4987 2 2
1205	,, Stockroom Reorganization		174 3 10
1150	,, Transfer to Reserve for *Berberis* Monograph	750 0 0	
500	,, Transfer to Library Account	500 0 0	
			1250 0 0
1796	,, Salaries, Wages and Pension		1894 8 1
15	,, Donations : Zoological Record	15 0 0	
2	Internation Union for Nature Protection	4 4 0	
—			19 4 0
3	,, International Assoc. for Plant Taxonomy—Subscription		3 10 0
108	,, Staff Annuities (Annual Premiums)		70 10 0
185	,, Investment of Compounders' Fees		184 0 0
28	,, Linnean Medal		27 13 4
	,, Balance at 30 April 1956 :—		
	Current Account at Bank	219 10 4	
	Deposit Account at Bank	500 0 0	
	Deposit Account Post Office Savings Bank	209 7 6	
	Cash in hand	11 0 7	
810			939 18 5

Note :—Balance of Composition Fees to be invested is £154 after deduction of Fees of deceased Compounders.

6834		£10913 6 6

Account

£		£ s. d.
267	By Periodicals	292 19 3
524	,, Binding	167 14 6
102	,, Books	96 8 2
	,, Balance at 30 April 1956 :—	
91	Current Account	144 4 3
984		£701 6 2

Restoration Fund

£		£ s. d.	£ s. d.
200	By *Transfer to Library Account*		
	,, Balance at 30 April 1956 :—		
	Current Account at Bank	82 2 9	
	Deposit Account at Bank	30 10 6	
	Deposit Account Post Office Savings Bank	616 14 0	
723			729 7 3*
923			£729 7 3

* £300 for Repair of Books from Linnaeus's Library to be paid.

Account

£		£ s. d.
1	By Postage on Library Books	17 7
—	,, Transfer to General Account	25 1 10
50	,, Balance 30 April 1956	24 6 2
51		£50 5 7

Special Accounts

(Trust and Reserve Funds)

Receipts	£ s. d.	£ s. d.
To Balance at 1 May 1955 :—		
Westwood Fund	80 3 10	
Trail Award Fund	4 14 3	
Crisp Award Fund	69 15 1	
Hooker Lecture Fund	128 1 7	
Goodenough Fund	52 4 1	
Minchin Fellowship Fund	22 10 5	
Carnegie Corporation Grant	419 3 7	
Reserve for Publications Fund	3990 5 3	
Auckland Univ. Grant (Chapman)	500 0 0	
		5266 18 1
Transfer from General Account for *Berberis* Monograph		750 0 0
Interest on Investments (gross) :—		
Westwood Fund	10 17 4	
Trail Award Fund	3 11 6	
Crisp Award Fund	13 19 0	
Hooker Lecture Fund	21 18 0	
Goodenough Fund	8 12 8	
Minchin Fellowship Fund	3 0 0	
Staff Pension Fund	10 1 9	
		72 0 3
		£6088 18 4

Payments	£ s. d.	£ s. d.
By Minchin Fellowship Fund transferred to Annual Contributions		24 0 0
,, Goodenough Fund transferred to Composition Fees		20 0 0
,, Reserve for Publications Fund transferred to General Account		2250 0 0
,, Auckland Univ. Grant (Chapman) transferred to General Account		500 0 0
,, Staff Pension Fund :—		
Purchase of £11 12*s.* 10*d.* 3 per cent Savings Bonds 1955–65		10 1 9
,, Balance at 30 April 1956 :—		
Westwood Fund	91 1 2	
Trail Award Fund	8 5 9	
Crisp Award Fund	83 14 1	
Hooker Lecture Fund	149 19 7	
Goodenough Fund	40 16 9	
Minchin Fellowship Fund	1 10 5	
Carnegie Corporation Grant	419 3 7	
Reserve for Publications Fund	1740 5 3	
Grant for *Berberis* Monograph	750 0 0	
		*3284 16 7
		£6088 18 4

* Including £181 5*s.* 10*d.* in Post Office Savings Bank and £3000 Deposit Account at Bank.

Investments on 30 *April* 1956

£	s.	d.			Market value 30 *April* 1956 £	s.	d.
			General Account				
1000	0	0	3½ per cent London County Consolidated Stock 1958–68	@ 85	850	0	0
1548	8	9	British Transport 3 per cent Guaranteed Stock 1978–88	@ 72½	1122	12	4
938	15	5	3½ per cent War Loan, 1952 or after	@ 73½	689	19	11
1000	0	0	2½ per cent Defence Bonds	@100	1000	0	0
2199	18	6	4 per cent Australia Stock 1961–64	@ 90½	1990	18	8
200	0	0	3 per cent War Stock 1955–59	@ 95	190	0	0
1139	13	0	3 per cent Savings Bonds 1955–65	@ 87½	997	3	11
3260	1	3	2½ per cent Consolidated Stock	@ 54½	1776	14	8
176	19	3	3 per cent Savings Bonds 1960–70	@ 79½	140	13	8
274	5	5	3 per cent Treasury Stock	@ 64½	176	18	0
233	10	10	3½ per cent War Loan 1952 or after	@ 73½	171	13	5
					£9106	14	7
			Library Account				
471	18	9	British Transport 3 per cent Guaranteed Stock 1978–88 (Bentham Bequest)	@ 72½	342	3	1
103	12	5	Surrey County 3 per cent Stock 1961–66 (Wakehurst Bequest)	@ 82	84	19	4
191	12	7	4 per cent Australia Stock 1961–64 (Walker & Morey Bequests)	@ 90½	173	8	6
107	2	1	2½ per cent Consolidated Stock (Stebbing Bequest)	@ 54½	58	7	5
530	0	0	3 per cent Savings Bonds 1960–70 (Tagart Bequest)	@ 79½	421	7	0
1414	7	11	2½ per cent Consolidated Stock (Flintoff Bequest)	@ 54½	770	16	11
					£1851	2	3
			Special Accounts				
	232	5	0	Metropolitan Water Board 3 per cent " B " Stock (Westwood Bequest)	@ 66½	154	8	11
£1063 10 7	667	14	2	,, ,, (Hooker Lecture Fund)	@ 66½	444	0	6
	163	11	5	,, ,, (Goodenough Fund)	@ 66½	108	15	6
	557	12	1	2½ per cent Consolidated Stock (Crisp Award Fund)	@ 54½	303	17	11
	156	7	2	,, ,, (Westwood Fund)	@ 54½	85	4	4
£380 10 6	74	14	6	,, ,, (Hooker Lecture Fund)	@ 54½	40	14	6
	149	8	10	,, ,, (Goodenough Fund)	@ 54½	81	8	11
	333	12	0	3 per cent Savings Bonds 1955–65 (Staff Pension Fund)	@ 87½	291	18	0
	11	12	10	,, ,, ,, 1955–56 (Staff Pension Fund)	@ 87½	10	3	9
	100	0	0	,, ,, ,, 1960–70 (Minchin Fund)	@ 79½	79	10	0
	102	3	11	3½ per cent War Loan 1952 or after (Trail Award Fund)	@ 73½	75	2	3
				F. C. STERN, *Treasurer.*		£1675	4	7

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1956 and found them correct. We have verified the Investments and Bank Balances.

16 May 1956.

W. B. KEEN & Co., *Chartered Accountants*,
Finsbury Circus House, Blomfield Street, London, E.C.2.

H. HAMSHAW THOMAS,
GEORGE TAYLOR,
H. R. HEWER,
A. TINDALL HOPWOOD,
F. L. BALFOUR-BROWNE,
W. E. SWINTON,
S. M. MANTON.
} *Audit Committee.*

Staff Pension Annuity. This figure is down due to retirement of the Librarian.

Investment of Composition Fees. £154 is awaiting Investment. This figure was £284, but the Council have decided that when a Compounder dies, the amount of his Composition Fee will be brought into the General Income Account as is done in most other Societies. The Composition Fees of deceased Fellows this Session amount to £130 which figure has been deducted from new Composition Fees received.

The Library Fund.

The account has a balance of £144 after paying for the usual items. The figure for binding is much smaller due to less binding having been put in hand whilst the binding was being regraded as mentioned earlier in this Report.

Library Restoration Fund.

This Fund shows a balance of £729 with an account for £300 awaited for the repair of books from Linnaeus's Library and this balance will be reduced to just over £400. Many more books from this unique Library need urgent repair and it is hoped that more contributions will be received from Fellows and friends so that this essential work may be put in hand. Only £6 for this Fund has been received this year.

We have just been informed that Mr. Barrington, a Fellow who died lately has left £1000 to be used for the benefit of the Library. I hope that more Fellows will follow the splendid example of Mr. Barrington, in leaving the Society such legacies.

Fellows' Postal Account.

This amount consists of deposits sent by Fellows towards the postage of books sent on loan. It may be remembered that before the recent war the Council agreed for a trial period, to pay the postage on books sent to Fellows. However, postage rates have risen very sharply and the Society can no longer afford to pay the postage on books sent to Fellows, which in some cases amount to as much as 2*s*. 9*d*. a parcel. It is of great assistance if regular borrowers of books would forward a deposit towards these postages rather than the Society having to claim postage with each parcel.

Trust and Reserve Funds.

I have already mentioned the Publications Reserve and the Auckland University Grant. The Goodenough Fund and Minchin Fellowship transfers are in respect of a Composition Fee and Annual Contributions.

Investments.

£184 Compounders Fees was earlier in the year invested in 3½ per cent War Loan and as I have said earlier £154 is still awaiting investment.

I should like to thank our General Secretary, Mr. O'Grady and our Clerk, Mrs. Ziegler for the excellent manner in which the accounts have been kept and for the conscientious way in which the work has been done.

Mr. Warton, our Librarian, is retiring this year after 40 years' service with the Society. I am sure we all wish to thank him for his long service with the Society and to wish him good health and happiness in his retirement.

If any Fellow wishes to ask any questions on these accounts, I will do my best to answer them.

The General Secretary presented his Report.

GENERAL SECRETARY'S REPORT

List of the Society.

Since the last Anniversary Meeting the Society has lost 35 members. The detailed statement is as follows :—

18 *Fellows by Death :*

Frederick James Fitzmaurice Barrington.
Alexander Francis Caddy.
Arthur Algernon Dorrien-Smith.
Antony Gepp.
Charles Hervey Grey.
Albert Henry Beaumont Kirkman.
George Woodrouffe Harris.
Francis John Lewis.
Frederick Kirkwood Makins.
Albert Pam.
J. Pryce-Jones.
Arthur William Rymer Roberts.
Otto Rosenheim.
Sir David Russell.
Sir Arthur George Tansley.
Chinnakavanam Tadulingham.
Lawrence Root Waldron.
George Stanley Woodcock.

5 *Foreign Members by Death :*

Valentin Dogiel.
Elmer Drew Merrill.
George Howard Parker.
Otto Rosenberg.
Carl Jorgen Wesenberg-Lund.

12 *Fellows by Withdrawal :*

Leslie John Bartlett, D.F.C.
Gian Singh Bhatia.
Mrs. Lille Ethel Brown.
Lionel Percy Clarke.
Patroclos Demetrion Critopoulos.
Frank Greenshields.
J. Donald Grose.
Ronald Gordon Newton.
Mrs. M. Jean Oldaker.
James Philp.
George Sherriff.
Redcliffe Nathan Salaman.

During the Session 41 Fellows, 7 Foreign Members and 7 ordinary Associates have been elected. The number of Fellows on the List is 831, with a further 21 Fellows elected but still to qualify. Fifty Foreign Members, 25 Associates *honoris causa* and 29 ordinary Associates. Four ordinary Associates have withdrawn during the year of which 3 have been elected Fellows.

The Library.

Between 1 May 1955 and 30 April, 26 books have been purchased ; 38 books, 98 parts of periodical publications and 197 reprints have been presented. During the same period the number of volumes bound from the general Library was 144 and a further 80 volumes from Linnaeus's Library have been repaired. The number of books borrowed by Fellows and Associates was 446. Five hundred and thirty-eight signatures were recorded in the Library Visitors' Book. Two Volumes of Plates of Selby's Birds have recently been presented by Mr. H. R. Marshall, F.L.S.

The Linnaean, Smithian Collections and Miscellaneous MSS. have been frequently consulted by research workers throughout the year and the Botanical and Zoological Curators have removed specimens for critical examination by specialists on 21 occasions.

The preparation of a Catalogue of the Smithian Herbarium started by Mr. S. Savage, F.L.S., is to be continued by Mr. R. H. Jeffers, F.L.S., who at present is working on the Richard Pulteney correspondence.

Eighty-two Meetings by 19 other Societies have been held in the Society's Rooms during the Session.

The PRESIDENT declared the Ballot for Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting: *President*: Dr. H. HAMSHAW THOMAS, M.B.E., F.R.S.; *Treasurer*: SIR FREDERICK STERN, O.B.E., M.C.; *Zoological Secretary*: Mr. H. R. HEWER, M.Sc.; *Botanical Secretary*: Dr. C. R. METCALFE.

The PRESIDENT gave his Annual Review of the Society's activities.

THE PRESIDENT'S REVIEW

In its 168th Session our Society has kept up the high standard which it has attained in recent years. A number of most interesting papers and lectures have been read, and the attendance of Fellows has been well maintained. The communications made at the meetings have covered a very wide field of Natural History, and we have had the pleasure of seeing many fine pictures of plants and animals in little-known parts of the world. In addition to the papers read a considerable number have been received and accepted for publication.

I do not propose to read a list of all those who have given papers, but I must express our appreciation of the lectures given by visitors from overseas, Dr. P. van Royen and Dr. J. Rzoska. I must also mention the visit of four members of the Staff of the Marine Biological Association who kindly came from Plymouth to tell us of the different aspects of the work they were carrying out. At another meeting we were privileged to hear about the interesting work of the Forest Products Research Laboratory at Princes Risborough. Our sincere thanks are due to the Directors of these two institutions and to those who came to address us.

Our rooms were filled, almost to their utmost capacity, for the President's Reception, at which a fine collection of exhibits was on view. These included living animals from British Guiana, exhibited by the Zoological Society; interesting fossil skulls from the British Museum (Natural History) shown by Dr. K. P. Oakley and Dr. Tindell Hopwood; fossil remains of Mesozoic Mammals recently discovered by Dr. D. M. Kermack, Dr. K. A. Kermack and Mrs. F. Mussett; two very interesting exhibits from the Royal Botanic Gardens, Kew; a fine exhibit illustrating plant hunting in Nepal, shown by the Director of the Royal Horticultural Society's Gardens, Wisley; and many others of a most diverse character. During the evening a beautiful film in colour, made during the expedition to Nepal, was shown. I should like to tender my warmest thanks to all those who brought exhibits or contributed in other ways to make this reception a memorable occasion.

We have lost by death four of our Foreign Members, Prof. G. Howard Parker of Harvard, elected in 1925; Dr. Elmer D. Merrill, who has often attended our meetings and was Linnean Medalist in 1939; Prof. Wesenberg-Lund of Denmark, who accepted membership in 1938; and Dr. Valentin Dogiel of Moscow who was elected in 1944. Among those who have died I wish to mention two of my old friends, both Linnean Medalists, Sir Arthur Tansley and Prof. Patrick Buxton. One of our deceased Fellows was Antony Gepp, who was elected to our Society, when I was one year old; he served on our Council from 1895 to 1898.

We had the pleasure of being able to send our congratulations to Dr. H. N. Ridley, C.M.G., F.R.S., Fellow since 1881 and Linnean Medalist, on the occasion of the 100th Anniversary of his birth, and also to our Senior Fellow Mr. William Stone, who reached his 99th birthday in January last.

Your Council has spent much time in considering the present financial position of the Society. In view of the greatly increased costs of every aspect of our work it was clear that some action must be taken. Every means of effecting economies has been considered, and some sources of expenditure have been eliminated. We can only maintain our essential functions by asking Fellows to pay an increased annual contribution, and consequently, after much discussion, the Council decided to propose a change in the Bye-Laws by which the subscription would be raised from £4 to £5. Fellows were notified of this proposal by post, and also in the statutory manner, and on 3 May 1956 a ballot was taken which showed that the change was approved by the necessary two-thirds majority. During the discussions on the matter it was suggested that the proposed increase will not provide the amount necessary for our full activities. The Treasurer and Council believe however, that by confining our expenditure to essentials and by obtaining continued support from external sources to assist us in meeting the costs of our scientific publications, we can avoid asking for a still higher contribution, which might well be a hardship to a large number of Fellows. In order to reduce expenditure it is proposed to supply to Fellows in the United Kingdom our *Proceedings* together with either the *Botanical* or the *Zoological Journal*, but not both. Savings on the costs of binding our periodicals are envisaged, and our withdrawal from the National Central Library scheme should result in an appreciable saving.

The Council is also considering the activities of the Society so that it may become of more interest to biological specialists. It has been suggested that periodical symposia should be arranged to last for a whole day and providing for the full discussion of a topic. Other suggestions have been made for the provision of meetings of a type different from those now held, and these will have to be considered by the new Council.

It is widely felt that our numbers have suffered by the formation of specialist societies, some of which have been fostered by us in their early stages, but which now, having no premises and no library to maintain, are able to arrange meetings and issue publications on the proceeds of a smaller subscription. May I ask Fellows to lose no opportunity of bringing to the notice of such of their friends who are qualified for membership of our Society, the advantages of belonging to an association with rooms in Piccadilly, serving some of the purposes of a Club, and with a very fine library from which books can be borrowed, in addition to the value of our meetings and publications.

I must make some preliminary statement about the Council's plans for the celebration of the 250th anniversary of the birth of Linnaeus next year, and also for the centenary of the meeting of our Society in 1858 when the memorable papers by Charles Darwin and Alfred Russel Wallace were read. For the centenary celebration a sub-committee of the Council has been formed with representatives of the Royal Society and the Geological Society, it has been agreed to strike medals similar to those made in 1908 for presentation to biologists of distinction in the field of Evolution. Special commemorative numbers of our Journals will be issued, and it is hoped to place a tablet on the wall of the Society's rooms recalling the famous meeting. For the celebrations in both 1957 and 1958, a reception and conversazione will be held, taking the place of the President's receptions in those years.

The Council is much concerned with the long delay in the publication of the *Proceedings* of the Society, which has been greatly aggravated by the strike in the printing industry this year. At the present time two parts of the *Proceedings*, two parts of the *Botanical Journal* and three parts of the *Zoological Journal* are in the press. Means are being sought whereby our publications can be published more punctually.

The Library Committee has initiated a review of the periodicals received in exchange, as gifts, or purchased. They number about 379 and represent publications on Natural History from all over the world. As the result of our survey, proposals will be submitted to the Fellows during the next session designed to save money on binding those publications infrequently consulted, and to economize in shelf space by disposing of the older parts of certain journals of a general character.

The stockroom of the Society's publications has been reorganized during the year with the aid of some energetic young students. The contents have been tabulated so that back numbers can be obtained without difficulty.

A number of our most precious books from the library of Linnaeus have been rebound by Messrs. Maltby of Oxford.

It is with much regret that I have to announce the impending retirement of our Librarian, Mr. W. S. Warton. When he leaves us next month he will have spent 40 years in the service of the Society, we shall greatly miss his genial presence and his unfailing help, and I should like to take this opportunity of thanking him on your behalf for the long and loyal service which he has rendered to us and our predecessors.

We again have to thank Mr. N. Y. Sandwith and Mr. W. H. Tams who have acted as Curators of the Linnaean collections.

Dr. George Taylor will represent the Society at the meeting of the International Union for the Protection of Nature at Edinburgh in 1956. We shall be represented this year at the International Geological Congress in Mexico by Dr. W. E. Swinton, and by Dr. John Smart at the International Congress of Entomology, in Canada.

In concluding this brief review I wish to thank our Officers and the members of the Council for the time and thought which they have devoted to the affairs of the Society. I should like to add my personal appreciation of the help that they have given to me as a new and untried President. Our thanks are especially due to Dr. George Taylor who retires from the office of Botanical Secretary, which he has held since 1951. He has been indefatigable in his efforts to promote the interests of our Society in spite of the heavy demands on his time of his other duties and his family responsibilities. He has arranged a long series of botanical programmes of unfailing interest, he has edited a notable series of numbers of the *Botanical Journal*, and he has greatly contributed to our administrative efficiency. Fortunately we shall still have the benefit of his wide knowledge and experience as a member of our Council.

The PRESIDENT then delivered his Address, "Plant Morphology and the Evolution of the Flowering Plants". **[Printed in full on page 125.]**

On its conclusion, Lt.-Col. R. B. Seymour Sewell, C.I.E., F.R.S., moved, "That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows". The motion was seconded by Mr. I. Henry Burkill, and being put to the meeting was carried with acclamation.

The PRESIDENT announced that he had appointed the following as Vice-Presidents for 1956–57:—Dr. L. HARRISON MATTHEWS, F.R.S., Dr. C. F. A. PANTIN, F.R.S., Sir FREDERICK STERN, O.B.E., M.C., and Dr. GEORGE TAYLOR.

Thereafter the PRESIDENT declared the Session of 1955–56 closed.

ADDITIONS AND GIFTS TO THE LIBRARY

1955–56

Note.—Names of donors are given in square brackets. Separate copies of papers which are included in periodicals received by the Library are no longer catalogued.

Ahmad, Nazir. Fish Wealth of East Pakistan, 1955. [Author.]
— — On Edible Tortoises and Turtles of East Pakistan, 1955. [Author.]
— — Control of Submerged Vegetation in Fish-ponds. [Author.]
— — Preservation and Curing of Fish in East Pakistan. [Author.]
— — Stocking of Fish-ponds in East Pakistan. [Author.]
— — Report on the Fish and Fisheries of East Pakistan, 1955. [Author.]
— — Achievements of the Directorate of Fisheries, East Bengal in the Field of Fish Culture, 1955 [Author.]
— — Mortality of Fish During Transport and Cultural Operation : Causes and Prevention. (Repr. Pakistan J. Sci., vol. 6, 1954.) [Author.]
Ahrenfeldt, R. H. Two British Anatomical Studies on American Reptiles. Part II.—Edward Tyson: Comparative Anatomy of the Timber Rattlesnake. (Repr. Herpetologica, vol 11, 1955.) [Author.]
Ainsworth, G. C. Medical Mycology. Pp. ix + 105. 8vo. *London*, 1952. [A. A. Pearson Bequest.]
André, J. Étude sur les Termes de Couleur dans la Langue Latine. Pp. 427. 8vo. *Paris*, 1949 [A. A. Pearson Bequest.]
Andres, Heirich. Flora des mittelrheinischen Berglandes. Pp. xxviii + 379. 8vo. *Wittlich*, 1920. [A. A. Pearson Bequest.]
Baines, Henry. The Flora of Yorkshire. Pp. xvi + 188. 8vo. *London*, 1840. [Mrs. W. C. Barton.]
Baker, John Gilbert. North Yorkshire. Pp. xiv + 671. 8vo. London, 1906. [Mrs. W. C. Barton]
Barbier, M. Description Synthetique des Russules. Pp. 45. 8vo. *Lux*, 1908. [A. A. Pearson Bequest.]
Barruel, Paul. *See* **Gaussen, Henri & Barruel, Paul.**
Bartholomew, J. G., *edited by.* The Survey Gazetteer of the British Isles. Pp. 928. 8vo. *London*, 1904. [Mrs. W. C. Barton.]
Bataille, F. Les Bolets. 2nd ed. Pp. 30. 8vo. *Paris*, 1923. [A. A. Pearson Bequest.]
— — Flore Analytique des Inocybes d'Europe. Pp. 27. 8vo. *Besançon*, 1910. [A. A. Pearson Bequest.]
— — Flore Monographique des Cortinaires D'Europe. Pp. 112. 8vo. *Besançon*, 1911. [A. A. Pearson Bequest.]
Beale, G. B. The Genetics of *Paramecium Aurelia*. Pp. xi + 179. 8vo. *Cambridge*, 1954.
Becker, Georges. La Vie Privée des Champignons. Pp. 197. 8vo. *Paris*, 1952. [A. A. Pearson Bequest.]
— — *See* **Heim, R. & Becker, C.**
Beeli, M. Flore Iconographique des Champignons du Congo. Parts 1 & 2. Pp. 45 & 8 pls. 4to. *Bruxelles*, 1935. [A. A. Pearson Bequest.]
— — **& de Keyser, M. L.** Les Champignons de Belgique. Pp. 282. 8vo. *Bruxelles*, 1922. [A. A. Pearson Bequest.]
Beers, A. H. *See* **Coker, W. C. & Beers, A. H.**
Benson, Lyman. Supplement to a Treatise on the North American Ranunculi. (Repr. Am. Midland Naturalist, vols. 52 & 53.) [Lyman Benson.]
Berhaut, Jean. Flore du Sénégal. Pp. viii + 300. 8vo. *Dakar*, 1954.
Bertrand, A. Succulent Plants other than Cacti. Pp. 112. 8vo. *London*, 1953. [E. Shurly.]
— — **& Guillaumin, A.** Cacti. Pp. 94. 8vo. *London*, 1955. [E. Shurly.]
Bewley, W. F. & Harnett, J. The Cultivation of Mushrooms. Pp. 109. 8vo. *London*, 1938. [A. A. Pearson Bequest.]
Bigeard, R. & Guillemin, E. Flore des Champignons supérieurs de France. Vols. I & II. Pp. xiv + 600; xx + 791. 8vo. *Paris*, 1909–13. [A. A. Pearson Bequest.]

Birmingham Natural History and Philosophical Society. Proceedings: vol. 18, part 3→ 1951→.
Blackman, F. F. Analytic Studies in Plant Respiration. Pp. ix + 231. 8vo. *Cambridge*, 1954.
Blackwell, L. & May, H. J. This is South Africa. Pp. 170. 8vo. *Pietermaritzburg*, 1947. [A. A. Pearson Bequest.]
Blatter, E. & Millard, W. S. Some Beautiful Indian Trees. Pp. xv + 165. 8vo. Bombay, 1955. [W. T. Stearn.]
Blezard, Ernest, *editor.* Lakeland Ornithology. Pp. 141. 8vo. *Arbroath*, 1954.
Bogdan, A. V. A List of Kenya Acacias with Keys for Identification. [Author.]
Boissier, E. & Reuter, G. F. Pugillus Plantarum Novarum Africae Borealis Hispaniaeque Australis. Pp. 134. 8vo. *Geneve*, 1852. [Mrs. W. C. Barton.]
Boltons, Jacob. Geschichte der Merckwürdigsten Pilze. Pp. xii + 72 & atlas. 8vo. *Berlin*, 1795. [A. A. Pearson Bequest.]
Bower, F. O. Plant Life on Land. Pp. 172. 8vo. *Cambridge*, 1911. [A. A. Pearson Bequest.]
Brazenor, C. W. The Mammals of Victoria. Pp. 125. 8vo. *Melbourne*, 1950 [Nat. Mus. Victoria.]
Bresadola, J. Iconographia Mycologica. Vols. 1–27. 8vo. *Milano*, 1926–40. [A. A. Pearson Bequest.]
Brian, M. V. Studies of Caste Differentiation in "*Myrmica rubra*" L. 2. The growth of workers and intercastes. [Nature Conservancy.]
Brian, R. C. Adsorption and Growth Regulation. [Author.]
Brinck, P. *See* **Hanström, B., Brinck, P., Rudebeck, C.,** *edited by.*
British Ornithologist' Club—Bulletin of. Vol. 75, No. 2, 1955. [Nature Conservancy.]
Brno. Acta Academiae Scientiarum Naturalium Moravosilesiacae, Brno, Czechoslovakia. Vol. 22 →. 8vo. *Brno*, 1950 →.
Brzek, Gabriel. History of Zoology in Poland till 1918. Part III. Pp. 455. 8vo. *Lublin*, 1955. [Polish Cultural Institute.]
Bulletin. Commission d'Études des Ennemis des Arbres, des Bois Abattus et des Bois Mis en Oeuvre. Nos. 7—17. 8vo. *Paris*, 1931–33. [A. A. Pearson Bequest.]
Bulletin de la Société Botanique du Centre-Ouest. For Years: 1937, 1938, 1939 and 1946. [A. A. Pearson Bequest.]
Bulletin de la Société des Naturalistes d'Oyonnax. 8vo. *Oyonnax*, 1947–53. [A. A. Pearson Bequest.]
Bulliard, Pierre. Dictionnaire Élémentaire de Botanique. 3rd ed. Pp. xii + 250. 4to. *Paris*, 1812. [A. A. Pearson Bequest.]
Burgess, R. *See* **Galloway, L. D. & Burgess, R.**
Bussard, L. Culture Potagêre et Culture Maraîchêre. Pp. 524. 8vo. *Paris*, 1920. [A. A. Pearson Bequest.]
Carter, G. S. The Papyrus Swamps of Uganda. [Author.]
Catcheside, D. G. The Genetics of Micro-organisms. Pp. viii + 224. 8vo. *London* 1951.
Cavaco, A. *See* **Keay, R. W. J. & Cavaco, A.**
Cejp, Karel. Monografie Hydnacéi Republiky Československé. Pp. 107. 8vo. *Praha*, 1928. [A. A. Pearson Bequest.]
— — Omphalia (Fr.) Quel. (From Atlas des Champignons de l'Europe, vol. IV.) Pp. 152 & 56 pls. 8vo. *Praha*, 1936. [A. A. Pearson Bequest.]
Česká Mykologie. Vols. 2—7 (incomplete), 1948–53. [A. A. Pearson Bequest.]
Chalk, L., Marstrand, E. B. & de C. Walsh, J.P. Fibre Length in Storeyed Hardwoods. (Repr. Acta Bot. Neerland. vol. 4, 1955.) [Dr. L. Chalk.]
Chislett, Ralph. Yorkshire Birds. Pp. 335. 8vo. *London*, s.a.
Chowdhury, K. A. & Ghosh, S. S. The Study of Archaeological Plant Remains and its Significance. (Repr. Trans. Bose Research Inst., vol. 20, 1955.) [Dr. K. A. Chowdhury.]
— — Wood-remains from Sisupalgarh. (Repr. Ancient India, No. 8, 1952.) [Dr. K. A. Chowdhury.]
Clegg, John. The Freshwater Life of the British Isles. Pp. 351. 8vo. *London*, 1952. [A. A. Pearson Bequest.]
Cleland, John Burton. Toadstools and Mushrooms and other larger Fungi of South Australia. Parts 1 & 2. Pp. 362. 8vo. *Adelaide*, 1934–35. [A. A. Pearson Bequest.]
Clements, F. E. The Genera of Fungi. Pp. 227. 8vo. *Minneapolis*, 1909. [A. A. Pearson Bequest.]
Coker, W. C. & Beers, A. H. The Boletaceae of North Carolina. Pp. viii + 96. 8vo *Chapel Hill*, 1943. [A. A. Pearson Bequest.]

Colgan, Nathaniel. Flora of the Country Dublin. Pp. lxx + 324. 8vo. *Dublin*, 1904. [Mrs. W. C. Barton.]

Commonwealth Oceanographic Conference. Proceedings, 1954. Pp. v + 93. 8vo. *Cambridge*, 1955. [Nat. Inst. Oceanography.]

Compton, R. H. Our South African Flora. Pp. xi + 100. 4to. s.l.e.a. [A. A. Pearson Bequest.]

Cook, W. R. Ivimey. *See* **McLean, R. C. & Cook, W. R. Ivimey.**

Cooke, M. C. Fungi Australiani. Pp. 56. 8vo. *Melbourne*, 1883. [A. A. Pearson Bequest.]

Correvon-Vaccari. Flora Alpina. 2nd ed. Pp. xxxvi + 199. 12mo. *Torino*, 1907. [A. A. Pearson Bequest.]

Costantin, M. J. & Dufour, M. L. Nouvelle Flore des Champignons. 2nd ed. Pp. lx + 291. 8vo. *Paris*. [A. A. Pearson Bequest.]

Crawshay, Richard. The Spore Ornamentation of the Russulas. Pp. 174. 8vo. *London*, 1930. [A. A. Pearson Bequest.]

Cunningham, G. H. The Gasteromycetes of Australia and New Zealand. Pp. xv + 236. 8vo. *Dunedin*, 1942. [A. A. Pearson Bequest.]

Curtis, William. Flora Londinensis; or, Plates and Descriptions of such Plants as grow wild in the Environs of London; with their Places of Growth and Times of Flowering; their several Names according to Linnaeus and other Authors. Fol. *London*, 1777. [A. A. Pearson Bequest.]

Czechoslovakia. Academy of Sciences of Czechoslovakia. Zoologicke a Entomologicke Listy. Vols. 2 →. 8vo. *Brno*, 1953 →

Dade, H. A. Colour Terminology in Biology. (From Mycolog. Papers, No. 1.) Pp. 21. 8vo. *Oxford*, 1943. [A. A. Pearson Bequest.]

Dakin, William J. Modern Problems in Biology. Pp. 80. 8vo. *London*, 1929. [A. A. Pearson Bequest.]

de Brebisson, A. Flore de la Normandie. Pp. xxxv + 518. 8vo. *Caen*, 1879. [Mrs. W. C. Barton.]

de Keyser, M. L. *See* **Beeli, M. & de Keyser, M. L.**

Denis, Jacques. Araignées du Tibesti récoltées par M. P. de Mire. (Repr. Bull. de l'Office Anti-Acridien No. 5, 1955.) [Dir. de l'Office National Anti-Acridien.]

Dennis, R. W. G. *See* **Pearson, A. A. & Dennis, R. W. G.**

Deraniyagala, P. E. P. Some Extinct Elephants, their Relatives and the Two Living Species. Pp. 161. 8vo. *Ceylon*, 1955. [Nat. Mus. Ceylon.]

de C. Walsh, J. P. *See* **Chalk, L., Marstrand, E. B. & C., Walsh, J. P.**

Donald, J. D. A Rebutia Reference and Synonymy. Pp. 40. 4to. *Brighton, s.a.* [E. Shurly.]

Donk, M. A. Homobasidiomycetae-Aphyllophoracae. Vol. I. (Repr. Meded. Nederland. Mycol. Ver. 18–20.) Pp. 69 + 200. 8vo. *Wageningen*, 1931 [A. A. Pearson Bequest.]

Druce, George Claridge. British Plant List. Pp. xl + 154. 8vo. *Arbroath*, 1928. [Mrs. W. C. Barton.]

Drury, Aubrey, *edited by*. Point Lobos Reserve. Pp. 96. 8vo. *California*, 1954. [Carnegie Inst. Washington.]

Dufour, M. L. *See* **Costantin, M. J. & Dufour, M. L.**

Dujarric de la Rivière, R. & Heim, Roger. Les Champignons Toxiques. Pp. 59. 4to. *Paris*, 1938. [A. A. Pearson Bequest.]

Dunston, T. F. G. W. & Dunston, A. E. A. Notes on some of the Musci found in South-West Wiltshire, especially round Donhead St. Mary. Parts 1 & 3. (Repr. Wiltshire Archaeolog. & Nat. Hist. Mag., vol. 49.) [A. A. Pearson Bequest.]

— — Notes on some of the Lichens found in South-West Wiltshire and especially round Donhead St. Mary. (Repr. Wiltshire Archaeolog. & Nat. Hist. Mag.] [A. A. Pearson Bequest.]

Dwerryhouse, Arthur R. Geological and Topographical Maps. Pp. vii + 133. 8vo. *London*, 1911. [Mrs. W. C. Barton.]

Dyson-Hudson, V. R. & Vockeroth, J. R. Some Natural Habitats of Larvae of *Drosophila subobscura* Collin and *D. Macularis villeneuve* (Dipt. Drosophilidae). (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Authors.]

East African Agriculture and Forestry Research Organization. Annual Report. 1995 → [Dir. E. Afric. Agric. Forestry Research Organisation.]

Edlin, H. L. Trees, Woods and Man. Pp. xv + 272. 8vo. *London*, 1956.

Engler, A. Syllabus der Pflanzenfamilien. Vol. 1. Pp. 367. 8vo. *Berlin*, 1954.

Favre, Jules. Les Associations Fongiques des Hauts-Marais Jurassiens et de quelques Régions Voisines. Pp. 288. 8vo. *Bern*, 1948. [A. A. Pearson Bequest.]

Fernando, Dorothy. Wild Flowers of Ceylon. Pp. xvii + 86. 8vo. *Mitcham*, 1954. [AUTHOR.]

Finney, D. J. & Varley, G. C. An Example of the Truncated Poisson Distribution. (Repr. Biometrics, 1955.) [AUTHORS.]

Fisher, Robert. Flowers of Grass. Pp. 47. 8vo. *London*, 1931. [A. A. PEARSON BEQUEST.]

Fitzgerald, H. P. Dictionary of the Names of British Plants. Pp. 90. 12mo. *London*. [A. A. PEARSON BEQUEST.]

Forestry Commission. Leaflet No. 32.—Pine Looper Moth. [FORESTRY COMMISSION.]

— — Leaflet No. 34.—Badgers in Woodlands. [FORESTRY COMMISSION.]

Fries, Elias. Monographia Hymenomycetum Sueciae. Vols. I & II. Pp. xi + 484; iv + 355. 8vo. *Leipzig*, 1938, repr. from 1854. [A. A. PEARSON BEQUEST.]

Frost, W. E. An Historical Account of the Char in Windmere. (Repr. The Salmon and Trout Mag., 1955.) [FRESHWATER BIOLOG. ASS.]

— — Observations on the Biology of Eels (*Anguilla* spp.) of Kenya Colony, East Africa. (Repr. Fishery Publications, No. 6, 1954.) [FRESHWATER BIOL. ASSOC.]

Gale, George W. John William Bews. Pp. 138. 8vo. *Pietermaritzburg*, 1954. [AUTHOR.]

Galliford, A. L. Two Lakes of Delamere Forest—an Ecological Contrast. (Repr. Proc. Liverpool Nat. Field Club, 1954.) [AUTHOR.]

Galloway, L. D. & Burgess, R. Applied Mycology and Bacteriology. Pp. ix + 186. 8vo. *London*, 1937. [A. A. PEARSON BEQUEST.]

Gaussen, Henri & Barruel, Paul. Montagnes. La vie aux hautes altitudes. Pp. 207. 4to. *Paris*, 1955. [MISS M. S. CAMPBELL.]

Ghosh, S. S. *See* **Chowdhury, K. A. & Ghosh, S. S.**

Gilbert, E.-J. Les Bolets. Pp. 254. 8vo. *Paris*, 1931. [A. A. PEARSON BEQUEST.]

— — La Mycologie sur le Terrain. Pp. 183. 8vo. *Paris*, 1928. [A. A. PEARSON BEQUEST.]

— — Méthode de Mycologie Descriptive. Pp. 566. 8vo. *Paris*, 1934. [A. A. PEARSON BEQUEST.]

— — La Spore des Champignons Supérieurs. Pp. 219. 8vo. *Paris*, 1927. [A. A. PEARSON BEQUEST.]

— — Le Genre Amanita Persoon. Pp. 186. 8vo. *Lons-le-Saunier*, 1918. [A. A. PEARSON BEQUEST.]

Gilbert, L. F. The Election to the Presidency of the Royal Society in 1820. (Repr. Notes and Records Roy. Soc. of London.) [AUTHOR.]

Gilbert-Carter, H. Glossary of the British Flora. Pp. xvii + 79. 8vo. *Cambridge*, 1950. [A. A. PEARSON BEQUEST.]

Gorham, Eville. On the Acidity and Salinity of Rain. (From Geochimica et Cosmochimica Acta, vol. 7, 1955.) [FRESHWATER BIOL. ASS.]

— — On Some Factors Affecting the Chemical Composition of Swedish Fresh Waters. (From Geochimica et Cosmochimica Acta, vol. 7, 1955.) [FRESHWATER BIOL. ASSOC.]

Green, F. H. W. A Remarkable Low Humidity. (Repr. Weather, vol. 8, 1953. [NATURE CONSERVANCY.]

— — The Nature Conservancy: Progress in the acquisition and safeguarding of reserves and sites of special interest. (Repr. Soc. for the Promotion of Nature Reserves Handbook for 1954.) [NATURE CONSERVANCY.]

Green, G. Gilbert. Cacti and Succulents. Pp. 240. 8vo. *London*, s.a. [E. SHURLY.]

Grenier, M. Ch. Flore de la Chaîne Jurassique. Pl. I. Pp. 1001. 8vo. *Paris*, 1865. [MRS. W. C. BARTON.]

Groom, Percy. Dry-rot in Wood. (From Forest Product Research, Bull. No. 1.) [A. A. PEARSON BEQUEST.]

Guétrot. Le Quarantenaire de la Société Mycologique de France. (1884–1924.) Pp. 412. 8vo. *Paris*, 1934. [A. A. PEARSON BEQUEST.]

Guillemin, E. *See* **Bigeard, R. & Guillemin, E.**

Haas, Hans. Pilze Mitteleuropas—Speisepilze I & II. Pp. 130 + 155. 8vo. *Stuttgart*, 1954. [A. A. PEARSON BEQUEST.]

Hanström, B., Brinck, P., Rudebeck, G., *edited by*. South African Animal Life. Results of the Lund University Expedition in 1950–51. Vol. 1 & 2. Pp. 518 + 576. 8vo. *Stockholm*, 1955.

Harmsen, Louis. *Merulius tignicola* Sp. Nov. og Dens forekomst I Danmark. (From Friesia, vol. 4, 1953.) [A. A. PEARSON BEQUEST.]

Harnett, J. *See* **Bewley, W. F. & Harnett, J.**

Hastings, Somerville. Toadstools at Home. 2nd ser. Pp. 78. 12mo. *London*, 1911. [A. A. Pearson Bequest.]

Hawkins, R. R., *edited by.* Scientific, Medical, and Technical Books published in the United States of America. Second Supplement, books published 1949–52. Pp. xi + 579. 8vo. *Washington*, 1953. [Librarian, American Embassy, London.]

Hegi, Gustav. Alpenflora. Pp. 68. 8vo. *München*, 1919. [Mrs. W. C. Barton.]

Heim, Roger. Lactarius. Pp. 83—97 & 3 pls. 4to. *Bruxelles*, 1955. [Author.]

— — Les Champignons. Pp. 143. 4to. *Paris*, 1948. [A. A. Pearson Bequest.]

— — La Reproduction chez les Plantes. Pp. 222. 8vo. *Paris*, 1939. [A. A. Pearson Bequest].

— — Le Genre Inocybe. Pp. 429. 8vo. *Paris*, 1931. [A. A. Pearson Bequest.]

— — Les Lactario-russulés du Domaine Oriental de Madagascar. Pp. 195. 8vo. *Paris*, 1938. [A. A. Pearson Bequest.]

— — Les Voies de l'Évolution chez les Champignons. [Author.]

— — Exposé Introductif. [Author.]

— — L'Action de l'Homme sur le Milieu Naturel. [Author.]

— — Inventaire et Raretés Mucologiques de la Forêt de Fontainebleu. [Author.]

— — Les Champignons Luminescents de l'Océanie. [Author.]

— — Champignons Termitophiles. [Author.]

— — Congres de Tunis—Discours. [Author.]

— — Le Genre *Ascopolyporus* en Amérique Centrale. [Author.]

— — General Relationship between Insects and Mushrooms. (Repr. Proc. Seventh Pacific Sci. Congress, 1949.) [Author.]

— — A propos des Lactaires à Lait Rouge. (Repr. Rev. Mycolog., vol. 18, 1953.) [Author.]

— — A propos de trois Chanterelles Américaines. (Repr. Rev. Mycolog., vol. 19, 1954.) [Author.]

— — Le Genre Bertrandia aux Iles Philippines. (Repr. Suppl. Colonial Rev. Mycology., vol. 19.) [Author.]

— — Classement Raisonne des Parasites Symbiotes, Commensaux et Saprophytes d'Origine Fongique. Associes aux Termites. [Author.]

— — *See* **Dujarric de la Rivière, R. & Heim, Roger.**

— — *See* **Maire, R. & Heim, R.**

Heim, R. & Becker, C. Un Nouveau Limacium du Jura—Hygrophorus Vaticanus. (Repr. Rev. Mycolog., vol. 17, 1952.) [Prof. R. Heim.]

Heinemann, P. Les Russules. Pp. 31. 8vo. *Ain-France*, 1950 [A. A. Pearson Bequest.]

Herrmann, Emil. Die Pilzsprache. Pp. 43. 8vo. *Heilbronn a. Neckar*, 1920. [A. A. Pearson Bequest.]

Hobby, B. M. *Cryptocephalus primarius* Harold (Col. Chrysomelidae) in Berkshire. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]

Hollos, Ladislaus. Die Gasteromyceten Ungarns. Pp. 210. Fol. *Leipzig*, 1904. [A. A. Pearson Bequest.]

Holttum, R. E. Gardening in the Lowlands of Malaya. Pp. 323. 8vo. *Singapore*, 1953. [Author.]

Hora, F. B. A Field Key to Four Hundred Common Mushrooms and Toadstools. (From Reading Naturalist, vol. 1, 1950.] [A. A. Pearson Bequest.]

Hutchinson, John. British Wild Flowers. Vols. 1–2. Pp. xxv + xxiv + 947. 8vo. *Bungay*, 1955. [Author.]

Huysman, H. S. C. Observations sur le Genre *Lepiota*. (Repr. Meded. Nederland. Mycolog. Ver. No. 28.) [A. A. Pearson Bequest.]

Hyde, H. A. & Wade, A. E. Welsh Ferns. A descriptive handbook. Pp. x + 131. 8vo. *Cardiff*, 1954. [Nat. Mus. Wales.]

Iconographia Mycologica. *See* **Bresadola.**

Ingold, C. T. Dispersal in Fungi. Pp. viii + 197. 8vo. *Oxford*, 1953. [Author.]

Jaccottet, J. Les Champignons dans la Nature. 3rd ed. Pp. 225. 8vo. *Paris*, 1943. [A. A. Pearson Bequest.]

Jackson, Rose. A List of the Flowering Plants and Ferns occurring within Six Miles of Haslemere. (From Science Paper, No. 4, 1924.) [A. A. Pearson Bequest.]

James, W. O. Plant Respiration. Pp. ix + 282. 8vo. *Oxford*, 1953.

Jean, Louis. Fleurs des Alpes. 5th ed. Pp. 286. 8vo. *Ophrys*, 1947.

Jenkin, T. J. Interspecific and Intergeneric Hybrids in Herbage Grasses. Parts lx–xv. (Repr. J. Genetics, vol. 53, 1955.) [Author.]

Jenson, H. A. P. Tidal Inundations Past and Present. (Repr. Weather, vol. 8.) [Nature Conservancy.]

Johnson, A. T. Plant Names Simplified. 2nd ed. Pp. xiii + 145. 8vo. *London*, s.a. [A. A. Pearson Bequest.]

Josserand, M. La Description des Champignons Supérieurs. (From Encyclopédie Mycolog., vol. XXI.) Pp. 338. 8vo. *Paris*, 1952. [A. A. Pearson Bequest.]

Journal für Hirnforschung. Vol. 1 → 8vo. *Berlin*, 1954 →

Kallenbach, Franz. Die Röhrlinge. (Bcletaceae.). Pp. 138 & 52 pls. 4to. *Leipzig* 1928. [A. A. Pearson Bequest.]

Kavina, Karel. Atlas Hub. Pp. 164. 8vo. *Praha*, 1926. [A. A. Pearson Bequest.]

Kawamura, Seiichi. The Japanese Fungi. 169 coloured pls. 8vo. *Daichi-Shoin* 1930. [A. A. Pearson Bequest.]

Kearney, Thomas H., Peebles, Robert H. & Others. Arizona Flora. Pp. viii + 1032. 8vo. *Berkeley*, 1951.

Keay, R. W. J. (Oxon). An Outline of Nigerian Vegetation. Pp. 55. *Nigeria*, 1953. [Author.]

— — **& Cavaco, A.** Sur une Espêce nouvelle de Grossera (Euphorbiaceae) de l'Ouest Africain. (Repr. Portugaliae Acta Biolog., vol. 6, 1955.) [R. W. J. Keay.]

Kelly, A. *See* **Kreiger, Louis C. C.**

Kennedy, P. G., Ruttledge, R. F. & Scroope, C. The Birds of Ireland. Pp. xv + 437. 8vo. *Edinburgh*, 1953.

Kern, Hs. Die Rohrlinge. Boletaceae. Pp. 91. 8vo. *Olten*, 1945. [A. A. Pearson Bequest.]

Keys, I. W. N. Flora of Devon and Cornwall. Pp. 375. 8vo. *Plymouth*, 1866. [Mrs. W. C. Barton.]

Khartoum—University College of—. Sudan. Annual Reports of the Hydrobiological Research Unit. Vol. 1 → 1953 →

Kidd, Mary Maytham. Wild Flowers of the Cape Peninsula. Pp. xvi + 94 pls. 8vo. *Cape Town*, 1950. [A. A. Pearson Bequest.]

Killermann, Seb. Pilze aus Bayern. Parts 1—5. (From Denkschr. Bayer. Bot. Gesell. Regensburg.) 8vo. *Regensburg*, 1922—33. [A. A. Pearson Bequest.]

Knauth, B. & Neuhoff, W. Die Milchlinge. (Lactarii). Pp. 32 & 6 pls. 4to. *Leipzig*, 1936. [A. A. Pearson Bequest.]

Knudson, B. M. The Distribution of Tabellaria in the English Lake District. (Repr. Proc. International Ass. of theoretical and appl. Limnology, vol. 12, 1955.] [Freshwater Biol. Assoc.]

Konrad, P. & Maublanc, A. Les Agaricales. Vols. I & II. Pp. 469 + 202. 8vo. *Paris*, 1952. [A. A. Pearson Bequest.]

Krieger, Louis C. C. Catalogue of the Mycological Library of Howard A. Kelly. Pp. v + 260. 4to. *Baltimore*, 1924. [A. A. Pearson Bequest.]

— — A Popular Guide to the Higher Fungi (Mushrooms) of New York State. Pp. 538. 8vo. *Albany*, 1935. [A. A. Pearson Bequest.]

Krombholz. Tafelin zu dem Mykologischen Werke. 76 pls. 4to. *Prag*, s.a. [A. A. Pearson Bequest.]

Kühner, Robert. Le Genre Mycena. Pp. 710. 8vo. *Paris*, 1938 [A. A. Pearson Bequest.]

— — Le Genre Galera. Pp. 240. 8vo. *Paris*, 1935. [A. A. Pearson Bequest.]

— — Titres et Travaux Scientifiques. Pp. 68. 8vo. *Lyon*, 1946. [A. A. Pearson Bequest.]

Lack, David. The Natural Regulation of Animal Numbers. Pp. viii + 343. 8vo. *Oxford*, 1954.

Lange, Jakob E. Studies in the Agarics of Denmarks. (Repr. Dansk Bot. Ark.) [A. A. Pearson Bequest.]

Langeron, M. Précis de Mycologie. Pp. 674. 8vo. *Paris*, 1945. [A. A. Pearson Bequest.]

Larsen, Poul. Fungi of Iceland. (From Botany of Iceland, vol. 2, 1931.) [A. A. Pearson Bequest.]

Lázaro É Ibiza, Blas. Compendio de la Flora Espanola. Vol. I&II. Pp. 826; 820. 8vo. *Madrid*, 1906—07 [A. A. Pearson Bequest.]

Lees, Howard. Biochemistry of Autotrophic Bacteria. Pp. viii + 112. 8vo. *London*, 1955. [Publishers.]

Le Cren, E. D. Year to Year Variation in the Year-class Strength of *Perca fluviatilis*. (Repr. Proc. International Ass. of theoretical and appl. Limnology, vol. 12, 1955.) [Freshwater Biol. Assoc.]

Lindau, Gustav. Hilfsbuch für das Sammeln parasitischer Pilze. 2nd ed. Pp. viii + 95. 8vo. *Berlin*, 1922. [A. A. Pearson Bequest.]
— — Die höheren Pilze. 3rd ed. Pp. xii + 497. 8vo. *Berlin*, 1928. [A. A. Pearson Bequest.]
Linnaeus Carolus. (Repr. Volapükagaded pro Nedänapükans, 1955.) [Dr. Klein.]
Linsley, E. G. *See* **Mayr, E., Linsley, E. G. & Usinger, R. L.**
Lister, Gulielma. The Mycetozoa: A short History of their Study in Britain; an Account of their Habitats generally; and a List of Species recorded from Essex. Pp. 54. 8vo. *London*, 1918. [A. A. Pearson Bequest.]
Liverpool Libraries, Museums and Arts Committee Bulletin. Vol. 5, Nos. 1 & 2, 1955. [H. Stansfield.]
Lohwag, Kurt. Moose des Waldes. 2nd ed. Pp. 66. 8vo. *Wien*, 1948 [A. A. Pearson Bequest.]
Lorenz, Konrad Z. King Solomon's Ring. Pp. xix + 202. 8vo. *London*, 1954. [J. G. Cockburn]
Lörtscher, Friedrich. Kleines Fremdwörterbuch der Pilzkunde. Pp. 71. 8vo. *Beren.* 1949. [A. A. Pearson Bequest.]
Lund, J. W. G. Three New British Algal Records and Spore-formation in *Micractinium pusillum* Fres. 1954. [Freshwater Biol. Assoc.]
— — The Importance of Algae to Waterworks Engineers. (Repr. J. Inst. Water Engineers, vol. 8, 1954.) [Freshwater Biol. Assoc.]
Lundell, S. & Nannfeldt, J. A. Fungi Exsiccati Suecici, Praesertim Upsalienses. Parts I—XXXVIII (No. 1–1900.) 8vo. *Uppsala*, 1934–50. [A. A. Pearson Bequest.]

Macan, T. T. A Key to the Nymphs of British Ephemeroptera. (Repr. Salmon and Trout Mag., 1955.) [Freshwater Biol. Assoc.]
— — Littoral Fauna and Lake Types. (Repr. Proc. International Ass. of theoretical and appl. Limnology, vol. 12, 1955.) [Freshwater Biol. Assoc.]
Mackereth, F. J. H. Ion-exchange Procedures for the Estimation of (1) Total Ionic Concentration, (2) Chlorides and (3) Sulphates in Natural Waters. (From Internationale Verein. für theoretische und angewandte Limnologie, Mitteil., No. 4, 1955.) [Freshwater Biol. Assoc.]
Macmillan, A. S. Popular Names of Flowers, Fruits, &c. Pp. 297. 8vo. *Yeovil*, 1922. [A. A. Pearson Bequest.]
Maire, R. Les Bases de la Classification Dans le Genre Russula. [A. A. Pearson Bequest.]
— — Notes Critiques sur quelques Champignons recoltes pendant la Session de Dijon de la Société Mycologique de France (Octobre 1909). Pp. 77; 40. 8vo. *Lons-le-Saunier*, s.a. [A. A. Pearson Bequest.]
— — Recherches Cytologiques & Taxonomiques sur les Basidiomycetes. Pp. 209. 8vo. s.l.e.a. [A. A. Pearson Bequest.]
— — **&Heim, R.** Fungi Catalaunici et Iberici. Pp. 120 + 146 + 128. 8vo. *Barcelona*, 1933–37. [A. A. Pearson Bequest.]
Malencon, M. G. Les Truffes Européennes. Pp. 92. 8vo. *Paris*, 1938. [A. A. Pearson Bequest.]
Marriott, St. John. British Woodlands and Supplement. Pp. xviii + 72. 8vo. *London*, 1925. [A. A. Pearson Bequest.]
Marshall, N. B. Aspects of Deep Sea Biology. Pp. 380. 8vo. *London*, 1954.
Marshall, S. M. & Orr, A. P. The Biology of a Marine Copepod. Pp. vii + 188. 8vo. *London*, 1955.
Marstrand, E. B. *See* **Chalk, L., Marstrand, E. B. & de Walsh, J. P.**
Mason, F. A. A Catalogue of Yorkshire Fungi. Pp. ix + 110. 8vo. *London*, 1937. [A. A. Pearson Bequest.]
Matthews, J. R. Origin and Distribution of the British Flora. Pp. 176. 8vo. *London*, 1955.
Maublanc, A. Les Champignons Comestibles et Vénéneux. Vols. 1 & 2. 3rd. ed. Pp. cclxxvii + 283. 8vo. *Paris*, 1946. [A. A. Pearson Bequest.]
— — *See* **Konrad, P. & Maublanc, A.**
May, H. J. *See* **Blackwell, L. & May, H. J.**
Mayr, E., Linsley, E. G. & Usinger, R. L. Methods and Principles of Systematic Zoology. Pp. ix + 328. 8vo. *New York*, 1953.
Melzer, V. Russula. Pp. 121. 8vo. *Prag*, 1944. [A. A. Pearson Bequest.]
— — Atlas Holubinek. Pp. 212. 8vo. *Praha*, 1945. [A. A. Pearson Bequest.]
Methuen, A. An Alpine ABC. Pp. x + 35. 12mo. *London*, 1922. [A. A. Pearson Bequest.]

Métrod, Georges. Les Mycènes de Madagascar. Pp. 146. 8vo. *Paris*, 1949. [A. A. Pearson Bequest.]

Michael, Edmund. Führer für Pilzenfreude. Vol. 1. Pp. 214. 8vo. *Leipzig*, 1939. [A. A. Pearson Bequest.]

Millard, W. S. *See* **Blatter, E. & Millard, W. S.**

Molina, R. T. & Pena, M. A. Los Trigos de la Ceres Hispanica de Lagasca y Clemente. Pp. xii + 516. 8vo. *Madrid*, 1952. [Inst. Nac. Investig. Agronom. Madrid.]

Möller, F. H. Fungi of the Faeröes. Part 1—Basidiomycetes. Pp. 294. 8vo. *Copenhagen*, 1945. [A. A. Pearson Bequest.]

— — Danish Psalliota Species. Pp. 220. 8vo. *København*, 1950. [A. A. Pearson Bequest.]

Moriyama, Hideo. Immunity. Pp. ix + 203. 8vo. *Tokyo*, 1955. [Author.]

— — The Nature of Viruses and the Origin of Life. Pp. xii + 454. 8vo. *Tokyo*, 1955. [Author.]

Morrison, J. T. Poisons. Pp. 79. 8vo. *London*, 1930. [A. A. Pearson Bequest.]

Mortimer, C. H. Some Effects of the Earth's Rotation on Water Movements in Stratified Lakes. (Repr. Proc. International Ass. theoretical and appl. Limnology.) [Freshwater Biol. Assoc.]

— — Models of the Flow-pattern in Lakes. (Repr. Weather, vol. 9, 1954.) [Freshwater Biol. Assoc.]

Moser, Meinhard. Die Blätter- und Bauchpilze. Pp. iv + 282. 8vo. *Jena*, 1953. [A. A. Pearson Bequest.]

Muenscher, W. C. & Rice, M. A. Garden Spice and Wild Pot-herbs. Pp. vii + 211. 4to. *New York*, 1955. [Publishers.]

Mundie, J. H. On the Distribution of Chironomidae in a Storage Reservoir. (Repr. Proc. International Ass. theoretical and appl. Limnology, vol. 12, 1955.) [Freshwater Biol. Assoc.]

Munro, Ian S. R. The Marine and Fresh Water Fishes of Ceylon. Pp. xvi + 349. 8vo. *Canberra*, 1955. [Author.]

McCann, Charles. Observations on the Polecat (*Putorius putorius* Linn.) in New Zealand. (From Records Dominion Mus., vol. 2, 1955.) [Author.]

— — The Lizards of New Zealand. (Dominion Mus. Bull. No. 17.) [Author.]

McLean, R. C. & Cook, W. R. Ivimey. Practical Field Ecology. Pp. 207. 8vo. *London*, 1946. [A. A. Pearson Bequest.]

Nannfeldt, J. A. *See* **Lundell, S. & Nannfeldt, J. A.**

Neilson-Jones, W. *See* **Rayner, M. C. & Neilson-Jones, W.**

Nelsen, Olin E. Comparative Embryology of the Vertebrates. Pp. xxiv + 982. 8vo. *New York* [1953].

Nelson, Erich. Gesetzmässickeiten der Gestaltwandlung im Blütenbereich. Pp. xii + 302. 4to. *Chernex-Montreux*, 1954.

Neuhoff, Walther. Die Gallertpilze (Tremellineae). Pp. 56 & 9 pls. 4to. *Leipzig*, 1936. [A. A. Pearson Bequest.]

— — *See* **Knauth, B. & Neuhoff, W.**

Noren Börje. Studies on Myxobacteria. Pp. 19. *Uppsala*, 1955. [Author.]

Nüesch, Emil. Die Trichterlinge. Pp. 279. 8vo. *St. Gallen*, 1926. [A. A. Pearson Bequest.]

Orr, A. P. *See* **Marshall, S. M. & Orr, A. P.**

Osborne, P. J. *Cetonia aurata* L. (Col.) and *Formica rufa* L. (Hym.). (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]

Patouillard, N. Essai Taxonomique sur les Families et les Genres des Hyménomycétes. Pp. 184. 8vo. *Lons-le-Saunier*, 1900. [A. A. Pearson Bequest.]

— — Les Hyménomycétes d'Europe. Pp. xi + 166. 8vo. *Paris*, 1887. [A. A. Pearson Bequest.]

Pearson, A. A. Cape Agarics and Boleti. (Repr. Trans. Brit. Mycol. Soc., vol. 33, 1950.) 8vo. *London*, 1950. [A. A. Pearson Bequest.]

— — **& Dennis, R. W. G.** Revised List of British Agarics and Boleti. (Annotated copy, repr. Trans. Brit. Malacolog. Soc., vol. 31.) 8vo. *London*, 1947. [A. A. Pearson Bequest.]

Peebles, Robert H. *See* **Kearney, Thomas H., Peebles, Robert H. & Others.**

Peltereau, M. Études et Observations sur les Russules. (From Bull. Soc. Myc. France, vol. 24, 1908.) [A. A. Pearson Bequest.]

Pena, M. A. *See* **Molina, R. T. & Pena, M. A.**

Pennak, Robert W. Fresh-water Invertebrates of the United States. Pp. ix + 769. 8vo. *New York*, 1953.

Pescott, R. T. M. Collections of a Century. Pp. ix + 186. 8vo. *Melbourne*, 1954. [Nat. Mus. Victoria.]

Phyton. Vol. 5, parts 1 → Argentina, 1955 →

Pigott, B. A. F. Flowers and Ferns of Cromer and its Neighbourhood. Pp. 99. 8vo. *London.* [A. A. Pearson Bequest.]

Pilát, Albert. Agaricales; Agaricalium Europaeorum Clavis Dichotomica. Pp. 719. 4to. *Praha,* 1951. [A. A. Pearson Bequest.]

— — The Bohemian Species of the Genus Agaricus. Pp. 142. 8vo. *Praha,* 1951. [A. A. Pearson Bequest.]

— — Hymenomycetes Novi vel minus Cogniti Cechoslovakiae, II. Pp. 109. 8vo. *Praha,* 1953. [A. A. Pearson Bequest.]

— — Velenovskyi Species Novae Basidiomycetum. Pp. 301. 8vo. *Prague,* 1948. [A. A. Pearson Bequest.]

— — Monographie des Espèces Européennes du Genre Lentinus Fr. Pp. 46. 8vo. *Prague,* 1946. [A. A. Pearson Bequest.]

— — Polyporaceae. Text and Atlas. Pp. 624. 8vo. *Praha,* 1936. [A. A. Pearson Bequest.]

— — Pleurotus Fries. (From Atlas des Champignons de l'Europe, vol. II.) Pp. 193 & 79 pls. 8vo. *Praha,* 1935. [A. A. Pearson Bequest.]

— — Monographie des Espèces Européennes du Genre Crepidotus Fr. Pp. 84. 8vo. *Prague,* 1948. [A. A. Pearson Bequest.]

Polish Academy of Sciences. Folia Biologica. Vol. 1 → 8vo. s.l., 1953 →

Poore, Duncan & Ross, Fraser. Ben Lawers and its Alpine Flowers. Pp. 55. 8vo. *Edinburgh,* 1955. [Nat. Trust for Scotland.]

Porsild, A. E. The Vascular Plants of the Western Canadian Arctic Archipelago. (From Nat. Mus. Canada Bull. No. 135.) Pp. iv + 226. 8vo. *Ottawa,* 1955. [Author.]

Portères, Roland. Les Sels alimentaires. Pp. vi + 77. 8vo. *Dakar,* 1950.

— — Le Genre Vanilla et ses Espèces. Pp. 95–290. 8vo. s.l.e.a.

Portevin, G. Ce qu'il faut savoir pour manger les Bons Champignons. Pp. 93. 8vo. *Paris,* 1939. [A. A. Pearson Bequest.]

Praeger, R. Lloyd. An Account of the Sempervivum Group. Pp. 265. 8vo. *London,* 1955. [A. A. Pearson Bequest.]

— — A Tourist's Flora of the West of Ireland. Pp. xii + 243. 8vo. *Dublin,* 1909. [Mrs. W. C. Barton.]

Priestley, J. H. & Scott, Lorna I. An Introduction to Botany. 3rd ed. Pp. xii + 627. 8vo. *London,* 1955. [Publishers.]

Quélet, Lucien. Flore Mycologique de la France et des Pays Limitrophes. Pp. xviii 492. 8vo. *Paris,* 1888. [A. A. Pearson Bequest.]

Ramsbottom, J. Fungi. An Introduction to Mycology. Pp. 80. 8vo. *London,* 1929. [A. A. Pearson Bequest.]

Rautavaara, Toivo. Suomen Sienisato. Pp. 534. 8vo. *Helsinki,* 1947. [A. A. Pearson Bequest.]

Rayner, M. C. Trees and Toadstools. Pp. 71. 8vo. *London,* s.a. [A. A. Pearson Bequest.]

— — **& Neilson-Jones, W.** Problems in Tree Nutrition. Pp. 184. 8vo. *London,* 1944. [A. A. Pearson Bequest.]

Rea, Carleton. British Basidomycetae. (Annotated copy.) Pp. 799. 8vo. *Cambridge,* 1922. [A. A. Pearson Bequest.]

Reijnders, A. F. M. Études sur le Développement et l'Organisation histologique dess Carpophores dans les Agaricales. (Repr. Rec. Trav. Bot. Neerland., vol. 41.) [A. A. Pearson Bequest.]

Repertorium Plantarum Succulentarum. No. 1 → 8vo. *Leeds,* 1950 → [E. Shurly.]

Reuter, G. F. *See* **Boissier, E. & Reuter, G. F.**

Revue de Mycologie. *Edited by* R. Heim. Vols. 1–18 (incomplete). 8vo. *Paris,* 1936–53. [A. A. Pearson Bequest.]

— — Vols. 2–8 (incomplete). 8vo. *Paris,* 1937–43. [A. A. Pearson Bequest.]

— — Supplement. Vols. 1–15 (incomplete). 8vo. *Le Mans,* 1936–50. [A. A. Pearson Bequest.]

— — Supplement Colonial. Vols. 11—18 (incomplete). 8vo. *Paris,* 1946–53. [A. A. Pearson Bequest.]

Reynolds, G. W. A New Aloe from Ethiopia. (Repr. J. S. African Bot., vol. 21, 1955.) [Author.]

— — A New Aloe from the Sudan. (Repr. J. S. African Bot., vol. 21, 1955.) [Author.]

— — A New Aloe from the Belgian Congo. (Repr. J. S. African Bot., vol. 21, 1955.) [Author.]

Rice, M. A. *See* **Muenscher, W. C. & Rice, M. A.**

Ricken, Adalbert. Die Blätterpilze. Vols. I & II. Pp. xxiv + 480; 112 pls. 8vo. *Leipzig*, 1915. [A. A. Pearson Bequest.]
— — Vademecum für Pilzfreunde. Pp. xxiv + 352. 8vo. *Leipzig*, 1920. [A. A. Pearson Bequest.]
Ridgway, Robert. Color Standards and Color Nomenclature. Pp. iii + 43. 8vo. *Washington*, 1912. [A. A. Pearson Bequest.]
Roberty, Guy. Petite Flore de l'Ouest-Africain. Pp. 441. 8vo. *Paris*, 1954.
Rolfe, R. T. & Rolfe, F. W. The Romance of the Fungus World. Pp. xx + 309. 8vo. *London*, 1925. [A. A. Pearson Bequest.]
Rolland, Leon. Atlas des Champignons de France, Suisse et Belgique. Pp. 120 planches. 8vo. *Paris*, 1910. [A. A. Pearson Bequest.]
Romagnesi, Henri. Les Rhodophylles de Madagascar. Pp. 164. 8vo. *Paris*, 1941. [A. A. Pearson Bequest.]
Ross, Fraser. *See* **Poore, Duncan & Ross, Fraser.**
Rudebeck, G. *See* **Hanström, B. Brinck, P., Rudebeck, G.,** *edited by*.
Ruttledge, R. F. *See* **Kennedy, P. G., Ruttledge, R. F. & Scroope, C. F.**
Sampson, K. & Western, J. H. Diseases of British Grasses and Herbage Legumes. Pp. 85. 8vo. *Cambridge*, 1941. [A. A. Pearson Bequest.]
Santapau, H. A Botanical Excursion to North Kanara, Bombay State, in May 1954. (Repr. J. Bombay Nat. Hist. Soc., vol. 53.) [Author.]
Såvulescu, Tr. Contributions a la Connaissance des Ustilaginées du Roumanie. (Repr. Ann. Inst. Recherches Agronom. Roumanie, vol. 7, 1935.) [A. A. Pearson Bequest.]
Schaeffer, Julius. Bestimmungstabelle für die Täublinge (Russula-Arten). Pp. 32. 8vo. *Krakau*, 1942. [A. A. Pearson Bequest.]
— — Bestimmungstabelle für die Täublinge (Russula-Arten). 2nd ed. Pp. 32. 8vo. *Krakau*, 1944. [A. A. Pearson Bequest.]
— — Die Russulae. 20 pls. 4to. s.l.e.a. [A. A. Pearson Bequest.]
— — Russula—Monographie. Pp. 295. 8vo. *Bad Heilbrunn*, 1952. [A. A. Pearson Bequest.]
Scott, Lorna I. *See* **Priestley, J. H. & Scott, Lorna I.**
Scroope, C. F. *See* **Kennedy, P. G., Ruttledge, R. F. & Scroope, C. F.**
Séguy, E. Code Universel des Couleurs. [Pp. lxviii + 48 planches.] 12mo. *Paris*, 1936. [A. A. Pearson Bequest.]
Shurly, E. A List of Specific Names and Synonyms of Mammillarias. (Published up to the end of the year 1940.) Pp. 93. [Author.]
— — A Supplementary List of Specific Names and Synonyms of Mammillarias. (Described 1940–52.) Pp. 6. 4to. *Brighton*, s.a. [Author].
Simpson, George Gaylord. The Major Features of Evolution. Pp. xx + 434. 8vo. *New York*, 1953.
Singer, Rolf. The Agaricales (Mushrooms) in Modern Taxonomy. Pp. 832. 8vo. *Tucuman*, 1949. [A. A. Pearson Bequest.]
— — The Boletineae of Florida with Notes on Extralimital Species. (Repr. Farlowia and American Midlands Naturalist.) 8vo. *Notre Dame, Indiana*, 1945–47. [A. A. Pearson Bequest.]
Smith, Alexander H. North American Species of Mycena. Pp. xviii + 521. 8vo. *London*, 1947. [A. A. Pearson Bequest.]
Smith, George. An Introduction to Industrial Mycology. 2nd ed. Pp. xii + 260. 8vo. *London*, 1942. [A. A. Pearson Bequest.]
Smith, Kenneth G. V. *Sympetrum flaveolum* L. (Odon., in Herefordshire). (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — *Phyto melanocephala* Meuc. (Dipt., Tachinidae) bred from *Armadillidium vulgare*. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — Some Additions to the Hemiptera-Heteroptera of Shropshire. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — Abdominal Teratology in the Genus *Chrysotoxum*.(Dipt., Syrphidae). (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — A Second British Record of *Myopa occulta* Meig. (Dipt., Conopidae) with notes on related species in the Genus. (Repr. J. Soc. Brit. Entom., vol. 5, 1955.) [Author.]
— — Notes on some Acarine Ectoparasites of Diptera. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — *Leopoldius signatus* Wied. (Dipt., Conopidae) in East Kent and its Known Distribution in Britain. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
— — *Syrphus arcuatus* Fln. (Dipt., Syrphidae) in Hampshire and Dorset. (Repr. Entom. Mon. Mag., vol. 91, 1955.) [Author.]
Smith, S. Gordon. Experiments with a Strain of *Lasiocampa quercus* AB. *Olivaceo-fasciata* Cockerell with Descriptions of two new Aberrations. (Repr. Entom., vol. 87, 1954.) [Author.]

Smith, S. Gordon. Notes on *Arctia caja* L. with a Description of a New Aberration. (Repr. Entom., vol. 88, 1955.) [AUTHOR.]

Smith, Worthington, G. Outlines of British Fungology. Supplement. Pp. xii + 386. 8vo. *London*, 1891. [A. A. PEARSON BEQUEST.]

— — Mushrooms and Toadstools. 4th ed. Pp. 64. 8vo. *London*, 1879. [A. A. PEARSON BEQUEST.]

Smith, W. G. & Others. Fungi Pamphlets. Vols. I & II. 8vo. s.l.e.a. [A. A. PEARSON BEQUEST.]

Smyly, W. J. P. Comparison of the Entomostraca of Two Artificial Moorland Ponds near Windermere. (Repr. Proc. International Ass. Theoretical and Appl. Limnology, vol. 12, 1955.) [FRESHWATER BIOL. ASSOC.]

Spectrum. The Magazine of the Hong Kong University Science Society. Nos. 2 → 8vo. *Hong Kong*, 1953 →

Spencer, L. G. Weed Control in Peas and Lucerne with IPC and CIPC. [AUTHOR.]

Stageman, Peter. A Bibliography of the First Editions of Philip Henry Gosse, F.R.S. Pp. xi + 87. 8vo. *Cambridge*, 1955. [DR. B. M. HOBBY.]

Stanford, K. C. A Garden of South African Flowers. Pp. viii + 63. 8vo. *Cape Town*, s.a. [A. A. PEARSON BEQUEST.]

Steers, J. A. The East Coast Floods. (Repr. Geogr. J., vol. 119, 1953.) [NATURE CONSERVANCY.]

Stephens, Edith L. Some South African Edible Fungi. Pp. viii + 35. 8vo. *Cape Town*, 1953. [A. A. PEARSON BEQUEST.]

— — Some South African Poisonous and Inedible Fungi. Pp. v + 31. 8vo. *London*, 1953. [A. A. PEARSON BEQUEST.]

Szemere, László. Gombáskönyv Kezdök Részére. Vol. I. Pp. 293. 8vo. *Budapest*, 1926. [A. A. PEARSON BEQUEST.]

Taylor, William Randolph. Sketch of the Character of the Marine Algal Vegetation of the Shores of the Gulf of Mexico. (Repr. Fishery Bull. 89.) [AUTHOR.]

— — Marine Algal Vegetation of the Marshall Islands in Comparison with other Tropical Areas. (Repr. Proc. 7th International Bot. Congress, 1950.) [AUTHOR.]

— — Marine Algal Flora of the Caribbean and its Extension in Neighbouring Seas. (From VIII Congrés International Bot.) [AUTHOR.]

— — A Synopsis of the Marine Algae of Brazil. [AUTHOR.]

— — Bryophyte Herbarium of the University of Pennsylvania. (Repr. Bryolog., vol. 26, 1926.) [AUTHOR.]

— — Marine Algae from Uruguay, Argentina, the Falkland Islands, and Strait of Magellan. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 24, 1939.) [AUTHOR.]

— — Notes on North Atlantic Marine Algae. L. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 22, 1937.) [AUTHOR.]

— — Notes on Algae from the Tropical Atlantic Ocean. III. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 21, 1936.) [AUTHOR.]

— — The Fresh-water Algae of Newfoundland, parts 1 & 2. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vols. 19 & 20, 1934 & 1935.) [AUTHOR.]

— — Marine Algae from Haiti Collected by H. H. Barlett in 1941. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 28, 1943.) [AUTHOR.]

— — Marine Algae from Peru and Chile. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 31, 1947.) [AUTHOR.]

— — Notes on the Marine Algae of Texas. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 26, 1941.) [AUTHOR.]

— — Notes on Algae from the Tropical Atlantic Ocean. II. (Repr. Papers Michigan Acad. Sci., Arts, and Letters, vol. 27, 1933.) [AUTHOR.]

— — Survey of the Marine Algae of Bermuda. (Report of Committee on Research Geological and Biolog. Sciences.) [AUTHOR.]

— — Marine Species of Vaucheria at Bermuda. (Repr. Bull. Marine Sci. Gulf and Caribbean, vol. 2.) [AUTHOR.]

— — Field Preservation and Shipping of Biological specimens. (Repr. Turtox News, vol. 28, 1950.) [AUTHOR.]

— — William Gilson Farlow Promoter of Phycological Research in America, 1844–1919. (Repr. Farlowia, vol. 2, 1945.) [AUTHOR.]

— — The Collecting of Seaweeds and Freshwater Algae, 1944 and 1945. [AUTHOR.]

— — The Relation of *Dichotomosiphon pusillus* to the Algal Genus *Boodleopsis*. (Repr. Papers Michigan Acad. Sci., Arts and Letters, vol. 38, 1953.) [AUTHOR.]

— — Distribution of Marine Algae in the Gulf of Mexico. (Repr. Papers Michigan Acad. Sci., Arts and Letters, vol. 39, 1954.) [AUTHOR.]

— — Bermudian Marine Vaucherias of the Section Piloboloideae. (Repr. Papers Michigan Acad. Sci., Arts and Letters, vol. 37, 1952.) [AUTHOR.]

Taylor, William Randolph. Reproduction of Acrosymphyton Caribaeum. (Repr. Papers Michigan Acad. Sci., Arts and Letters, vol. 36, 1952.) [AUTHOR.]
— — Notes on *Vaucheria longicaulis* Hoppaugh. (From Madrono, 1952.) [AUTHOR.]
— — On the Production of New Cell Formations in Plants. (Repr. Contrib. Bot. Labor. University Pennsylvania, vol. 4.) [AUTHOR.]
— — A Morphological and Cytological Study of Reproduction in the Genus *Acer*. (Repr. Contrib. Bot. Labor., University Pennsylvania, vol. 5.) [AUTHOR.]
— — Notes on Algae from the Tropical Atlantic Ocean. IV. (From Papers Michigan Acad. Sci., Arts and Letters, vol. 40, 1955.) [AUTHOR.]
— — Essays in the Natural Sciences in Honor of Captain Allan Hancock. [AUTHOR.]
— — Chromosome Structure in Mitosis and Meiosis. (Repr. Proc. Internat. Congress Plant Sci., 1, 1929.) [AUTHOR.]
— — Remarks following Professor Otto Heilborn's Paper. (Repr. Proc. Internat. Congress Plant Sci., 2, 1929.) [AUTHOR.]
Thomas, H. Hamshaw. Presidential Address. Experimental Plant Biology in Pre-Linnean Times. (From History of Science, vol. 12, 1955.) [AUTHOR.]
Troll, Wilhelm. Praktische Einfürung in die Pflanzenmorphologie. Part 1. Pp. vi + 258. 8vo. *Jena*, 1954.
Tulasne, L. R. and C. Selecta Fungorum Carpologia. Translated into English by GROVE, W. B. Vols. I–III. Fol. *Oxford*, 1931. [A. A. PEARSON BEQUEST.]
Usinger, R. L. *See* **Mayr, E., Linsley, E. G. & Usinger, R. L.**
Varley, G. C. *See* **Finney, D. J. & Varley, G. C.**
Velenovský, Jos. České Houby. Vol. 1. Pp. 950. 8vo. *Praha*, 1920. [A. A. PEARSON BEQUEST.]
— — Novitates Mycologicae. Pp. 208. 8vo. *Pragae*, 1939. [A. A. PEARSON BEQUEST.]
Venables, L. S. V. & Venables, U. M. Birds and Mammals of Shetland. Pp. xii + 391. 8vo. *Edinburgh*, 1955.
Venezuelica—Acta Biologica. Vol. 1, Nos. 10 → [UNIVERSIDAD CENTRAL DE VENEZUELA.]
Vermeulen, P. Epipactis Helleborine, a Problem of Nomenclature. (Repr. Acta Bot. Neerland., 1955.) [AUTHOR.]
Veselý, Rudolf. Amanita. (From Atlas des Champignons de l'Europe, vol. I.) Pp. 80 & 40 pls. 8vo. *Praha*, 1934. [A. A. PEARSON BEQUEST.]
Vockeroth, J. R. *See* **Dyson-Hudson, V. R. & Vockeroth, J. R.**
Vuillemin, Paul. Les Champignons parasites et les Mycoses de l'Homme. (From Encyclopédie Mycologique, vol. II.) Pp. 290. 8vo. *Paris*, 1931. [A. A. PEARSON BEQUEST.]
Wade, A. E. *See* **Hyde, H. A. & Wade, A. E.**
Wallis, T. E. Textbook of Pharmacognosy. Pp. xi + 578. 8vo. *London*, 1955. [AUTHOR.]
Walty, Hans. Planches Suisses de Champignons. 40 pls. 8vo. *Zurich*, 1947. [A. A. PEARSON BEQUEST.]
— — Schweizer Pilztafeln. Vols. II and III. 8vo. *Zurich*, 1944–47. [A. A. PEARSON BEQUEST.]
Wardlaw, C. W. Embryogenesis in Plants. Pp. ix + 381. 8vo. *London*, 1955.
Wedgwood, M. L. A Catalogue of the Plants in the Wedgwood Herbarium at Marlborough College. Pp. viii + 238. 8vo. *Arbroath*, 1945. [MRS. W. C. BARTON.]
Western, J. H. *See* **Sampson, K. & Western, J. H.**
Wigglesworth, V. B. The Physiology of Insect Metamorphosis. Pp. viii + 152. 8vo. *Cambridge*, 1954.
Wilson, G. Fox. Pests of Ornamental Garden-plants. Pp. v + 128. 8vo. *London*, 1937. [A. A. PEARSON BEQUEST.]
Zimmermann, Walter. Evolution. Pp. ix + 623. 8vo. *Freiburg*, 1953.

BENEFACTIONS

1955–56

LIST *in accordance with Bye-Laws, Chap* 17, *Sect.* 1, *of all Donations of the amount or value of Twenty pounds and upwards, received during the past five years.*

1951

The Royal Society: Grant-in-aid of publications, £750.
Mr. James Insch, F.L.S.: Bequest of Library of works on Tea.
Mr. John H. Robins: The collected correspondence of Richard Pulteney, F.R.S., F.L.S.

1952

The Royal Society: Grant-in-aid of publications, £1250.
The John Innes Horticultural Institution; Gift to Library Fund, (£10, 1950, 1951 and 1952), £30.

1953

Auckland University College: Grant towards cost of Prof. V. J. Chapman's paper on New Zealand Algae in *Journal, Botany* (press), £500.
The Royal Society: Grant-in-aid of publications, £950.
Mr. J. D. Snowden: Gift towards cost of paper on *Sorghum* in *Journal, Botany* (press), £25.
Gift to Library Fund in Memory of Miss Maud Williams, F.L.S., £100.
Dr. Hugh Scott, F.R.S.: Cost of blocks for plates and £293 0*s.* 11*d.* towards cost of printing his Gughé Highlands' paper in *Proceedings*, 163.

1954

Mr. H. Womersley, A.L.S.: Gift towards cost of paper in *Journal, Zoology*, No. 288, £20.
Imperial Chemical Industries Limited: Gift to Library Fund, £21.
The Royal Society: Grant-in-aid of publications, £1000.
Mr. A. A. Pearson, F.L.S.: Bequest of Myological Library.

1955

The Royal Society: Grant-in-aid of publications, £1250.
The Percy Sladen Memorial Fund, Cost of printing *Transactions*, Ser. 3, Vol. 1, Part 3, £625 3s 6d.
Imperial Chemical Industries Limited: Gift to Library Fund, £21.
The John Innes Horticultural Institution,: Gift to Library Fund, (£10 1953, 1954 and 1955), £30.

OBITUARIES

Frederick James Fitzmaurice Barrington, M.S., F.R.C.S., F.L.S. It is not easy to write a satisfactory biographical sketch of this remarkable man, his interests were so wide and comprehensive. He died suddenly on 23 March 1956 at the age of 72 after a very full and active life.

Very early he showed evidence of his ability by gaining numerous prizes at school and an exhibition for entrance to University College Hospital. He took his Fellowship of the Royal College of Surgeons in 1909 and his M.S. London in 1911. He became a genito-urinary surgeon of the first rank and did fundamental research on micturition, contributing numerous papers between 1914 and 1931 to the Physiological and Pathological Society of Great Britain and Ireland of which he was a member. These papers have become classical. For many years he was surgeon to University College Hospital and St. Peter's Hospital for Stone. Apart from the above-mentioned contributions on micturition he appears to have published remarkably little. In all his scientific work he was meticulously accurate and had a remarkable memory. He maintained a healthy scepticism of the conclusions of others till he had tested them for himself. He was a great teacher and earned the respect and affection of his students and of all those with whom he worked.

He was elected a Fellow of the Linnean Society in 1949. Throughout his life he was a keen biologist, his greatest interests being in phanerogamic botany, ecology and ornithology. At the time of his death he was working at the Royal Veterinary College in London and investigating the feeding habits and metabolism of moles.

He never drove a car, was not interested in games, but was a keen yachtsman and a moderate shot.

Barrington was known to the writer as a fellow student. He was always a man of few words, but what he said was brief and to the point; there was never any circumlocution. In spite of his rather distant manner he always showed the greatest regard for the well-being of his patients; of this the writer can speak feelingly after undergoing a major operation at his hands. He was kindness itself.

Barrington detested public speaking and committee work, though his accurate memory served him well in scientific debate. He was more laconic than usual when interviewing women, probably from shyness. He never married. He lived simply and was a non-smoker, but when he entertained he did so most liberally. He had a keen sense of humour and what he said was sometimes hardly suitable for mixed company. He was tall, very thin, upright, with a closely cropped head, and edentulous, all of which gave him a somewhat cadaverous appearance. He scorned hats, overcoats and mufflers, merely carrying a light macintosh in wet weather. In the country he always carried a pair of field-glasses for observing birds. He is greatly missed by all of his friends who knew him well.

LESLIE B. C. TROTTER.

Patrick Alfred Buxton C.M.G., F.R.S., who died on 13 December 1955, though not a fellow of the Linnean Society was awarded its Gold Medal in 1953 for his contributions to the study and prevention of insect-borne tropical diseases. In spite of his professional interest in the application of entomological knowledge to preventive medicine and of his nuemrous official duties, he remained until the end a naturalist who might well have found a place amongst fellows of the Society.

Born on 24 March 1892, he was educated at Rugby and later read the Natural Science Tripos at Cambridge where he was a Fellow of Trinity College

from 1916–21. He also obtained a medical qualification at St. George's Hospital. While his first published work was on the somewhat unexpected subject of the structure of the brain of the primitive moth, *Micropteryx*, he was soon caught up by the war and served in Iraq and Persia. This was followed by two years work as Entomologist to the Government of Palestine. These visits to countries on the fringes of the great deserts gave him an interest in the peculiar problems which face animals in such places and he published in 1923 (reprinted in 1955) his delightful work *Animal Life in Deserts*. Here he first showed that aptitude which he later carried much further for the study of the relation of the fauna to its physical environment and that scepticism as to popular theories of animal coloration with which he sometimes enlivened public discussions. He now left the Middle East and spent two years (1924–25) as leader of a mission to the Pacific of which a permanent record remains in the nine volumes of the *Insects of Samoa*. He retained to the end of his life a deep interest in the problems posed by the distribution of animal life in the Pacific Islands. In 1925 he was appointed Director of the Department of Entomology of the London School of Hygiene and Tropical Medicine, becoming in 1933 Professor of Medical Entomology in the University of London. It was here that he began those studies of African medical entomology and of the influences of temperature and humidity on insects for which he is likely chiefly to be remembered. This side of his life finds a fitting monument in his great book *The Natural History of the Tsetse Flies*, which was published a few months before his death. Apart from summarizing a great volume of work in many fields, much of it influenced or inspired by the author, the book is an outstanding example of good scientific writing. The wonderful lucidity makes the matter seem sometimes less weighty than it really is.

Buxton's most important contribution to the study of the tsetse fly and of other insects of medical importance was to measure some of the climatic factors not only in the general habitat but often in the microhabitat where they actually lived. Such measurements suggested laboratory experiments in which the same species of insects were artificially subjected to the same climatic factors at various intensities. This made it possible to predict the conditions necessary for survival and to explain, to a considerable extent, the observed distribution of the species in the field. In the case of the tsetse fly this led ultimately to its local elimination by modification of the vegetation. Buxton's contributions in this field were recognized by his election to the Royal Society in 1943 and by the award of the Mary Kingsley Medal of the Liverpool Society of Tropical Medicine. Of recent years his advice was much needed on committees, especially on those dealing with colonial affairs, and in 1947 he was awarded the C.M.G. for his services. On committees he was always candid and sometimes deliberately provocative but he was kinder to his juniors than he was to those of his seniors or equals with whom he disagreed.

He was a regular attendant at the meetings of the Royal Entomological Society of London of which he was president in 1942 and in 1953–54. He had also a continuing interest in the work of the Freshwater Biological Association which he helped to found. More recently, perhaps in preparation for a retirement he never enjoyed, he had begun to study the fungus-gnats and had already made a number of interesting discoveries. He was always a keen horticulturist and had wide interest in general natural history. He will be much missed at meetings of British biologists.

O. W. Richards.

Professor **James Peter Hill**, D.Sc., F.R.S., Professor Emeritus of University College London, died on 24 May 1954. He passed away in his beloved study, where he had worked for nearly fifty years, with his microscope and slides, on

which he had been occupied, close at hand. He left bereft two daughters, Catherine (Mrs. Kirkham Jones), formerly lecturer in Histology in her father's Department at University College, and Margaret (Mrs. Patrick) at present in the Department of Physiology at the Royal Veterinary College, University of London.

Since the death of Professor Hill, notices, all more or less formal, as to his life and work, have appeared in many journals. The most comprehensive, fully documented account is that of D. M. S. Watson (*Biog. Mem. Fell. Roy. Soc.*, **1**, 1955). In this contribution I feel that I might be allowed to put on record a more personal tribute to his memory.

I knew J. P. Hill as teacher and friend in Sydney, when he was in his early thirties, and where he occupied the position of Demonstrator in Biology, and Lecturer in Embryology. The University of Sydney in those days was at the height of its scientific reputation and had some remarkable men on its staff: Haswell, head of the Biology Department, renowned for his work on the Marine Fauna of Port Jackson; Liversidge (Chemistry); Edgeworth David (Geology); and J. T. Wilson (Anatomy) in whose department Grafton Elliot Smith was just beginning his epoch-making researches on the monotreme brain.

Hill came amongst this wonderful assembly of scientific talent as a young undergraduate, 19 years of age, returning later to Edinburgh to complete his B.Sc. degree. It is a remarkable thing to be able to record that the monumental discovery of the presence of a true allantoic placenta in the marsupial Perameles was made while he was yet an undergraduate, and it was only three years after his arrival in Sydney and when he was 22 years of age that he communicated to the Royal Society of New South Wales in 1895 his preliminary note announcing this fact. This discovery, offering as it did a new interpretation of the origin of the marsupialia, electrified the zoological world and immediately put Hill in the front rank of investigators. I can well remember how, in 1904, Professor Edgeworth David (afterwards Sir Edgeworth David) who had just returned from England where he had heard outstanding reports of Hill's work, addressing his geology classes said that "he was a young man of whom we all should be proud". David was a great favourite with students and his words made a tremendous impression. To the advanced students in Biology, Hill was a wonderful inspiration. His character was impeccable with a shy yet irresistibly charming manner (characteristic of him all his life) kindly and helpful on all occasions, full of the knowledge of his subject, and its ramifications and therefore always able to satisfy our thirst for knowledge. To us he was something of a god. Of the four students who were at that time taking Advanced Zoology, three were later appointed to chairs in the subject while the fourth went to an important position in the newly-formed Commonwealth Department of Scientific and Industrial Research.

In London Hill was always spoken of as "J. P.". I cannot remember him being called this in Sydney. where he was affectionately known as "Jummy". I can well remember the remarkable course of lectures he gave to the Honours students on the Embryology of the Mammalia, in which, for the first time, he promulgated his ideas as the ancestral history of the marsupials. It will be remembered that he referred to this series of lectures in his brilliant monograph on the Development of the Native Cat (*Q.J.M.S.*, **56**, 1910).

In those young days, as in his later years, Hill never spared himself. His lectures, his demonstrations, his slides, his drawings, were all models of preparedness. When his teaching for the day was over, he went to his own room, and any stray student, who for some reason or other, had to return to the Department in the evening, would be sure to find Hill's light burning and he himself hard at work. Much of his equipment was improvised. He was from the first a great advocate of photomicrography, and some of the remarkable

photographs, which illustrate his paper on the Native Cat were taken with a simple apparatus arranged on a bench and lit by gas. Sections, slides, drawings and photographs were mostly prepared by himself, with little expert help. Later on in London he had the assistance of two devoted servants, the late F. J. Pittock, F.P.S., and H. Barker. The latter still carries on his successful work in microtechnique in University College.

It was a sad day in Sydney when we said goodbye to our good friend " Jummy " as he left us to accept the Jodrell Chair of Zoology at University College London. It was then that Sydney presented him with a beautiful Zeiss microscope, of which he was so very proud and which served him to the end.

In London Hill continued his brilliant researches and equally brilliant teaching. When in 1929 I brought to England a series of monotreme embryos I naturally went to my old teacher, and thus began many years of collaboration which resulted in the publication of our combined monotreme studies, as well as some by Hill himself and by his daughter, C. J. Hill. Our monotreme stages were pooled, and for years all vacations were given over to this work. We used to interrupt it from time to time with golf, of which game Hill was no mean exponent. There came also a free period in the evenings when Hill, who was a great lover of music, listened for an hour or so to some good musical programme on the wireless.

He was a stimulating and superlatively careful investigator, varying work with occasional sparkles of humour of which one in particular occurs to me. Throughout our investigations he persistently referred to the fantastic-looking first polar body in the monotreme ovum as the " Loch Ness Monster ".

Our association was interrupted by the war, and to our great disappointment could not be resumed. During the years of collaboration I was admitted to the intimate home life of this great family, where happiness and hospitality were the keynotes of living. Hill's laboratory at University College was the Mecca of embryologists from the world over and sooner or later practically every well-known comparative anatomist would find his way there, and later, in the years of J. P.'s so-called retirement to " Kanimbla " his home in Finchley.

Hill had his share of sorrows; first the death of his only son John in Sarawak in 1935, then the passing of a beloved son-in-law in 1952, and lastly the loss in 1953 of the sweet and kindly lady, full of wit and understanding, who had been the head of his home for over fifty years, and to whose gentle encouragement and unobtrusive care, as J. P. often said, he owed so much.

Hill was awarded the Linnean Gold Medal in 1939. At the time of his death he was still actively at work, and just a few days before, had been at the Zoological Society's offices to discuss details of the publication of the paper written by himself and Osman Hill on the pouch young and new born of Dasyurus. Hill left behind a substantial amount of unfinished work, which, it is hoped, will be completed, edited and published.

With the death of J. P. Hill there passes one of the last (and perhaps the greatest) of those comparative anatomists who made the first half of the present century a period of outstanding achievement in the realm of pure embryology. He was a great scientist and a great gentleman, and his passing has given much sorrow to students, friends and scientists throughout the world.

T. Thomson Flynn.

Thomas Johnson, D.Sc., F.L.S., 1863–1954. Born in Barton on Humber, Johnson received an education of a classical trend at Elmfield College, York. Afterwards, he studied at the Royal College of Science, London, where he was appointed as Demonstrator of Botany in 1885. Five years later, at the early age of 27 years, he was appointed as Professor of Botany at the Royal College

of Science, Dublin. On the dissolution of that college in 1926, a special chair of botany was established for Johnson at University College, Dublin, which he held till his retirement in 1928.

In 1891, Johnson organized the Botanical Department of the National Museum and became its keeper. As a further addition to his activities, he set up in 1900 and directed for ten years the first seed-testing and plant-disease station of the newly-formed Department of Agriculture and Technical Instruction for Ireland. As well as conducting the normal services rendered in these several capacities, he carried out investigations of many pathogens of economic importance. In this field his best-known work was done on *Synchytrium endobioticum* and *Spongospora solani*, towards the control of which he made substantial contributions. Johnson made extensive studies of the algae of which he made many additions to the herbarium of the National Museum. His versatility was further expressed in his favourite study of fossil plants chiefly of Irish and Scottish origins; he made many valuable additions to knowledge in this field in which he continued to work to the end.

As a teacher, Johnson stood high in the estimation of his colleagues and of his students whose affection he secured with his imperturbable good humour. His wide and intimate knowledge was always at the disposal of his students to whom as well he readily quoted from his vast memory the views of other botanical workers. Perhaps his outstanding characteristic was a minute insistence on every feature that could contribute to a knowledge of continuity in the relationship of plants.

PATRICK O'CONNOR.

John Pryce-Jones, M.Sc., F.L.S., F.R.I.C. (1894–1956) who died on 4 March 1956, was born at Pencader, Carmarthenshire, and educated at Llandyssul Grammar School and the University College of Wales, Aberystwyth. He was trained as a physical chemist and after service in the R.N.V.R. as a Meteorological Officer during the First World War, joined the staff of Reckitt and Sons Ltd. Hull, in 1919, and remained with that firm until his retirement in 1955. He was appointed a Director of Reckitts (Colours) Ltd. when that company was formed in 1950.

A man of wide interests his early work dealt largely with the manufacture and uses of ultramarine blue in which he became an expert. He made a special study of lapis lazuli and acquired a wide knowledge of its use in mediaeval times and also of pigments used in oil paintings and methods used in the faking of old masters. Subsequently he extended his interest in rheology and published a series of papers on thixotropy and allied subjects in the *Journal of the Oil and Colour Chemists Association*. He also designed a "double Couette" viscometer consisting of two concentric cylinder instruments in series and was the first to observe the so-called Weissenberg phenomenon.

Pryce-Jones will be better known to most Fellows of the Society for his studies of bees and especially of honey. He was elected a Fellow of the Linnean Society on 29 April 1948, but had previously communicated an important paper to the Society entitled "Some problems associated with nectar, pollen and honey", published in the *Proc. Linn. Soc., Lond.* 155 pp. 129–174.

He became a leading authority on honey and published articles on the subject in *Bee World*, *Scottish Bee Keeper* and *Welsh Bee Journal*, and wrote a chapter on "The rheology of honey" in *Foodstuffs: Their Plasticity, Fluidity and Consistency*, edited by G. W. Scott Blair.

He had acquired an enormous amount of information about honey and various other problems concerned with bees and it is most unfortunate that he had not the time to publish more of it. His death is a great loss to science for in addition to his wide knowledge he was an excellent lecturer and had done

much to stimulate scientific interests, especially in the East Riding of Yorkshire.

He married in 1921 Miss Helen Bune who survives him.

EDWARD HINDLE.

Dr. **Albert Henry Beaumont Kirkman**, F.R.C.S.E., F.L.S., was born 19 May 1872, and qualified at Guy's Hospital in 1899 and served in the South African War in part charge of the first X-ray unit to be used by the R.A.M.C., and then on the Cape Government Railways as Railway Medical Officer. In 1913 he took up private practice in Staplehurst, Kent, but in 1915 entered the R.A.M.C. as a surgeon in France. On being invalided out of the Army he returned to private practice in Seaton, Devon, but in 1923 he once more sold his practice and visited many parts of the world during nine months as ship's surgeon in the Merchant Navy. In 1924 he again settled in private practice in Staplehurst, where he was President of the local branch of the British Legion for ten years. During the Second World War he was Medical Officer in the Home Guard and lecturer on first aid under the Red Cross. In 1946 he retired to Seaton, Devon, and more recently to Cirencester, where he died on 21 February, 1956, aged 83. His first wife having died in 1943, he later married Dr. Eveline McCabe, who, with a daughter of his first marriage, Mrs. Machili Brown, survives him.

From childhood he was intensely interested in natural history, fishing, and shooting. He became a first-class shot with both rifle and shot gun, as well as an expert fly fisher. Not long after the South African war he carried out his first big-game expedition, and collected and housed in his garden a small menagerie of wild pets, including ostriches, monkeys, a jackal, and a lioness with which he still played long after she had become full-grown ; but when she ate her friend the jackal, he gave her to a zoo. In 1908 he carried out a second big-game expedition to N.W. Rhodesia, and in 1913 a third to Lake Bangweolo. He took fine heads of lion, rhinoceros and various other species. Like many former big-game hunters, he became greatly concerned about the disappearing fauna of the world, and a very active member of the Fauna Preservation Society. He was elected a Fellow of the Linnean Society in 1938.

As time passed he became increasingly interested in the humanitarian and scientific aspects of wild life, and became very popular in schools and elsewhere as an honorary lecturer on natural history, his lectures having always a humanitarian tone. He was particularly concerned at the boyish hooliganism by which he found British wild birds to be menaced in the nesting season, and he exercised a civilizing influence on the children in his neighbourhood. He was one of the earliest members of U.F.A.W. (The Universities Federation for Animal Welfare) and became its Hon. Secretary for Wild Life, giving special attention to the problem presented by the cruel gin trap ; he died only five months before the legal prohibition of this instrument in Britain became absolute. In 1952 he opened an active campaign in connection with cruel treatment of horses in Nigeria, and raised sufficient funds to purchase all the humane-killer pistols and ammunition which the Nigerian veterinary service could use in that connection.

During his eighty-second year he gave lectures on natural history in 37 schools, and during the week before his death he had made an engagement to lecture in a new school. His personality was as genial as it was stalwart, and the interest in natural history which he aroused in young minds, always with a humane colouring, will continue to iunflence those who listened to him.

C. W. H.

John Withers Lester, F.L.S., died on 9 August 1956, at Charing, Kent, after a long and painful illness bravely borne, at the tragically early age of 47.

His death inflicts a grievous loss on the Zoological Society of London in which he was Curator of Reptiles and Insects, and on a wide circle of friends both at home and abroad.

Jack Lester was a born naturalist who from his very early years was fascinated by living animals and their ways, and he developed great skill in finding, capturing, and keeping alive small animals of all kinds from insects to frogs, toads, and snakes. He had a great understanding of what, for want of a better term, may be called animal " psychology ", so that when the opportunity came in later years for handling larger creatures he got into very close relationships with his birds and mammals which accepted him in the way that animals have towards those who have won their confidence.

Lester was an ideal companion on a field expedition whether in the tropics or nearer home. For several years after 1950 he and a group of friends including the late F. J. F. Barrington made one or two week-end trips to Romney Marsh to study and collect the Marsh Frog *Rana ridibunda*, a gathering that became known facetiously as the " Ridi Bund ". Even on these comparatively tame expeditions Jack's splendid qualities were conspicuous—his patience and tenacity, his skill in finding and capturing the quarry, his equanimity on falling headlong into a marsh ditch in the small hours of a frosty March morning, and his good companionship on at last reaching the snug inn parlour to discuss the restoratives left out against our return. And so with more ambitious and arduous expeditions, as several Fellows of the Linnean Society well know from personal experience. On an expedition to East Africa, within a few hours of taking his leave he found himself swimming in the Mediterranean, using his thumbs to plug the worst leaks in a defective rubber dinghy containing the women and children who had scrambled out of their ditched aircraft. They were fortunately picked up without loss of life after many dismal hours, and taken to Malta, whence Jack continued his flight and successfully completed his mission, although he had lost all his kit and special apparatus.

Lester was born at Walsall, Staffordshire, in 1908, and was educated at Wrekin College where he excelled at Rugby football and boxing, and devoted all his spare time to natural history. When he left school he entered the service of a bank, a walk of life for which he must have been peculiarly unfitted, but he later spent six years in the employment of the Bank of British West Africa in Sierra Leone. This was very much more congenial to him for he used his spare time in observing and collecting animals of all kinds and getting to know the country ; he was thus able to send home many interesting living specimens to several Zoological Gardens. He was especially interested in the Amphibians and Reptiles, and acquired a great knowledge of these animals both by practical experience and by reading. He resigned from his position with the Bank on his marriage in 1936 and joined the staff of the Paignton Zoo at Primley, Devon, then the property of the late Herbert Whitley, a most unusual and interesting personality. On the outbreak of war three years later he joined the R.A.F. and served at various overseas stations—his service included a tour of duty in Sierra Leone.

In 1946 Lester was appointed Curator of Reptiles to the Zoological Society of London, a post which he filled admirably and which widened further the circle of his friends. During the next few years he made several field trips to East and West Africa from which he returned with valuable collections of interesting animals for the Gardens at Regent's Park. In 1954 he led a joint expedition of the Zoological Society and the British Broadcasting Corporation to Sierra Leone to collect animals and make films for television broadcasting. This expedition succeeded in finding and filming for the first time a very rare bird, the White-necked Picathartes, and in bringing back the only living specimen ever to have been seen in Europe. The resulting series of " Zoo Quest "

television programmes was so successful that a second expedition was organized to British Guiana in 1955 with Lester again the leader. The zoological results were equally gratifying, but he was unable to take part in the television broadcasts for, on his return, he was struck down by the illness that was to end fatally.

In January 1956 the Zoological Society awarded Lester its silver medal in recognition of his splendid work on his various expeditions. The award gave him great pleasure and satisfaction, but it wrung the hearts of his friends to see him brought into the Meeting to receive it sitting almost helpless in an invalid chair.

Lester was a man of great personal charm and kindness ; he was always ready to give his time and knowledge to any enquirer about his favourite subject of herpetology, and yet with all his great experience he was most modest and unassuming. He had made good his lack of academic training in zoology by wide reading, and was ever keen to impart his love of natural history to the young. He was deservedly popular with all the staff of the Zoological Society, and with a wide public to which he became known through his many lectures to schools and natural history societies, and through his broadcasts and television appearances.

Lester did not publish much scientific work, in spite of his great practical knowledge and experience, but had he lived it is certain that he would in due course have recorded a great quantity of valuable information. He was always more of a practical man than a pundit, but he was developing a maturity of great promise.

Lester leaves a widow and four daughters to whom he was devoted.

L. Harrison Matthews.

Frederick Kirkwood Makins, who was elected a Fellow of our Society in 1935, died at his home in Bruton, Somerset, on 7 February 1956. He was recruited to the Indian Forest Service in 1912, having taken his diploma in Forestry at the University of Oxford. He had also studied at Cambridge where he was an Exhibitioner in Natural Sciences at Trinity College.

His service in India was divided between the provinces of Bihar and Orissa and the United Provinces. He was transferred to the latter after recovering from blackwater fever, for which at that time the province of Bihar and Orissa was notorious. While in the United Provinces he was for some time in charge of the Chakrata Division and later was an instructor in Botany at the Forest College, Dehra Dun. He retired from India in 1928.

In his retirement Makins was active in the interest of home forestry and became secretary of the Southwestern Woodland Association Limited and also secretary of the Southwestern Branch of the Home Grown Timber Marketing Association ; upon both of which organizations he left his mark. He also did a considerable amount of work as a forestry consultant.

He published an excellent book *Identification of Trees and Shrubs* (Dent and Sons, Ltd.) which met with much success. Another of his works was *British Trees in Winter* (Dent and Sons, Ltd.).

Makins will be much missed in forestry circles in the west country for he was a man to whom forestry owed much.

N. L. Bor.

Elmer Drew Merrill, recipient of the Linnean Medal in 1939 and a Foreign Member of the Society from 1933, died on 25 February 1956, at the age of 79.

He was born 15 October 1876, in a village of fewer than 50 houses situated at the outfall of Lake Auburn in the State of Maine (U.S.A.) which had been a logging centre, but in his day, following the removal of the forests, was passing

over to agriculture. His relatives were typical of such a settlement and his school was the village school. From that beginning he made his way to eminence by the solid worth of a splendidly logical mind, by unfailing application to whatever was in hand, by a directness that put first things first and by a true humanity. The village schoolmistress discovered his ability and went to considerable pains to secure his education beyond the age of 13; and in the High School in Auburn to which he proceeded an ambition came to continue learning which sent him to the State College at Orono where, according to an unfinished autobiography, his mind pieced together without particular effort the knowledge that was offered to him. It happened that the College became the University of Maine while he was a student; and he qualified from it as a Bachelor of Science. Next by examination he obtained a minor post in the vast Bureau of Agriculture at Washington where after three years of work on the classification of American grasses he was, so to speak, put on the rails by selection for the appointment of "Botanist" in the new administration which the United States had set up for the Philippine Islands. He arrived at Manila in May 1902, and through the next ten years worked with a singleness of purpose and manifest success at building up a herbarium and preparing for the writing of a descriptive Flora of the Archipelago. This he expected to write himself. However there was a rather urgent need for a less ambitious local Flora to promote teaching in the new University; accordingly he wrote after ten years of fact-collecting, a descriptive *Flora of Manila*—a volume of 490 pages giving the characters of just over 1000 species demonstrably to be found in an area of 40 square miles about the city, the half of them owing their place to Man.

By a not unnatural sequel, given the title of Associate Professor of Botany, he was required to divide his time between instructing in the University and collecting, studying and incorporating into his herbarium the plants of the islands. At the time of his appointment his departmental relations were uncertain, but they were soon settled by assigning to him considerable independence as in charge of a "Division" with appropriate accommodation in the composite Bureau of Science, its buildings alongside those of the University. So far good for his convenience; but the teaching could be at times very exacting. In 1919 there was what he regarded as another raid into his time for research. He had shown such competence that he was required to take the post of Director of the Bureau. And this he remained until he left the Philippines in 1923.

I propose to give an account of his botanical work before touching on his administrative work, for he began to have a reputation as a botanist before the other came; and it was as a botanist that our Society sought to enrol him as a member.

There was nothing for him in Manila when in 1902 he took up his post except an unfurnished room and a few bundles of dried plants which the head of the Forestry service, Captain G. P. Ahern, had caused subordinates in training to collect. Merrill began his own collecting in his back yard and continued it by a long journey northwards through the centre of Luzon until he reached the sea again at Aparri. This journey provided an abundant sampling of the flora; and taking his collection along with Ahern's he went to Java to name the species by comparisons in the herbarium at Buitenzorg. Two months sufficed; and he returned with the nucleus for his own herbarium and also with a copy of the catalogue of the library at Buitenzorg to direct the purchases he had to make for a library of his own.

In his first years of service he could spend six months in the field and six in working up the field results. The Forest service in particular needed his work. They, because they worked so much through native agents, asked for a

" Dictionary of vernacular plant-names " which he prepared for them. Soon the foresters were rather overloading him with plants for determination ; but that was to the good ; others who botanized in their leisure came forward as collectors and he trained his own Filipino collectors to be in the field when he could not be and to go whither he would send them. In this way the internal collecting was extensive. For external material which brought him named plants from other countries he arranged exchanges widely and effectively, and with great generosity. Unceasing attention to detail kept the growth of the collection in order and an extensive elaboration of card-catalogues in support, under plant names and bibliographic, made possible an astonishingly large output of taxonomic papers. These were printed chiefly in the *Philippine Journal of Science* which came into existence because of him and largely for him. When he left the Philippines in 1923 the herbarium held 275,000 mounted sheets, two-thirds Philippine and one-third external, chiefly Malaysian ; and the library was botanically unsurpassed in the East. As the organization grew Merrill began to have some doubts regarding the consummation of the Flora ; and when in 1919 the post of Director of the Bureau of Science was imposed, he saw that it could no longer be descriptive : therefore he adjusted his plans by converting the Flora into an enumeration.

Merrill's sense of order kept him strict in matters of nomenclature : the naming in the herbarium had to be perfected whether it was to serve a Flora or an enumeration. Where the typification method of fixing a botanical name could not be applied—as to species based on descriptions of the earlier botanists—he turned for help to the plant-populations from which they drew. The idea of understanding the old writers in this way was not exactly new : Hohenacker, for instance, had thought of collecting in Malabar in order to understand Rheede's *Hortus malabaricus* ; but no one had followed up the idea as Merrill did. He started with Blanco's area and collected over it intensely ; with the aid of C. B. Robinson he made close acquaintance with the flora of Amboina so as to know what Rumpf could have utilized ; he could rely on the Dutch in Java for material connecting his knowledge with that of the younger Burman ; and for Loureiro he was able to obtain collections from Hue in Annam and he visited Canton himself. No student of the plants of Asia can afford to neglect the series of papers which he wrote on the works of these ; in chronological order they were :—" An interpretation of Rumphius's *Herbarium amboinense* ", 1917 ; " Species *blancoanae*, a critical review of the Philippine species of plants described by Blanco and Llanos ", 1918 ; " A review of the new species described by N. L. Burman in his *Flora indica* ", 1921 ; and " A commentary on Loureiro's *Flora cochinchinensis* ", drafted in 1919, but publication delayed until 1935. They count in botanical history for more than their titles suggest ; and Merrill's subsequent authority in taxonomic matters very largely grew out of these studies.

The Bureau of Science in Manila was a composite organization ; it served the Government in Public Health by preparing vaccines and sera, and in developing mineral resources and fisheries ; it conducted chemical analyses and tested structural materials ; it had an anthropological side and it housed the research divisions of botany and zoology; The Director of a body thus built had need to understand the handling of much remote from his own speciality. It suffices to say that Merrill after 17 years of contacts in the Bureau had enough knowledge of the other divisions for his administrative ability to cover the whole. Therewith began what it is not wrong to call his greater services to Science.

Merrill was able to use his position in the Bureau to good effect : in the Bureau he and other scientists of it and of the University and representatives of certain commercial companies engaged in developing the natural resources

of the Philippines, held informal monthly meetings whereat they discussed broad distributional problems. He had by then his *Enumeration* in such a form that he could lay his dispersal statistics before the zoologists, and the zoologists present would lay theirs ; whereupon the geologists would discuss how the observed conditions could have come about. A geologist, Dr. Roy E. Dickerson, laid the conclusions before the Third Dutch-Indies Natural History Congress at Buitenzorg in 1924 and Merrill was able to incorporate much in the last volume of his *Enumeration* (1926). He and the zoologists had found their views on Philippine biological sub-provinces in accord.

The first part of the *Enumeration* had gone to press in 1921 ; the last part appeared in 1926 ; and half of this last part is devoted to reviewing the rest. The species admitted amount to 8120. The following figures perhaps suggest better the volume of work behind that. The synonyms reduced are in the neighbourhood of 11,200 and the vernacular names recorded, of 13,600. The review assesses the specific endemism of the Philippine archipelago at 69 per cent though the generic endemism at not as much as 3 per cent, which contrast, as pointed out, indicates rich geologically late speciation ; further analyses point to the linkage being more than twice as great with Malaysia west of Wallace's line than with Malaysia east of Weber's line. Dickerson had suggested the name Wallacea for the belt of rugged lands and deep seas between Wallace's and Weber's lines ; but the name is perhaps superfluous. The Australian element in the Philippines is described ; and the virtual absence of a link with Formosa stressed, though the plants of the Luzon pine forests point clearly to a link with Asia. These linkages are discussed from the geological angle ; and a valuable contribution to biogeography emerges.

In 1945 the Japanese invaders of the Philippines by an unpardonable act of vandalism destroyed the whole of the collections on which the *Enumeration* had been built. Thanks to Merrill's extensive exchanges with botanical institutions in many parts of the world, he saved from destruction not a little that one may call collateral evidence for the facts of the *Enumeration*. To the very end of his life Merrill was at times putting names to new collections submitted to him from Manila in an attempt to rebuild something in replacement of the destroyed collections.

Mention has been made of Merrill's *Dictionary of Philippine Plant-names* (1903). He did not then point out, but he soon came to realize that American plant-names had been brought to the Philippines with American plants and that there were other names in the list which had come from the direction of India and some from China. The names from America directed his attention to the Island of Guam at which Spanish ships on the voyage from Mexico to Manila had habitually called for water and fresh provisions. Plants such as they carried to Manila were likely to be left also in Guam. With his interest in the Pacific aroused by this, he obtained collections of dried plants from Guam ; on these he reported in 1914, 1919 and 1946. The first Pan-Pacific conference met in Honolulu in 1920, and to it he went, getting thereby into personal touch with Pacific vegetation. He began then to collect data regarding Pacific floras : a bibliographic card-index grew into his *Bibliography of Polynesian Botany* (ed. 1 in 1924 ; ed. 2 in 1937). A card index of plant-names was made which remains unpublished. His knowledge of the Pacific grew so that at a later date at short notice he could write for his Government his *Emergency Food-plants and Poisonous Plants of the Islands of the Pacific* (1943) followed by his *Plant-life in the Pacific* (1945). By this time he had added the Pacific to the area of the world on which he was a leading authority. Neatly he calls the Pacific flora an attenuated Malaysian flora. So many species in any Pacific island have reached it by Man's intervention, that he became also an authority on the human geography of the Pacific.

Here the narrative must return to somewhat earlier events in Manila where from 1919 he was occupied in the production of his *Enumeration* and by 1923 had most of it in manuscript. Late in the latter year he was asked if he would accept the post of Dean of the College of Agriculture in the University of California. The reader who has in mind his botanical achievements to that date possibly thinks the selection strange, but its purpose was administrative. American institutions from the private generosity by which they often grow, are apt to be pulled askew by conditions attached to the gifts. In this appointment on which he entered in 1924, in the appointment of Director of the New York Botanic Garden (1930) and in the appointment of Administrator of the Harvard Collections (1936) it was his wisdom in finding the true lines of advance which was asked for : and each appointment was by invitation. Each carried a title of Professor with it but the responsibility asked for was administrative. The professorial title attached to the last was Arnold Professor of Botany ; but his familiar title was Director of the Arnold Arboretum. In these successive responsibilities it was only by long hours that he continued his botanical research, but he always contrived to do so. The administrative burden fell from his shoulders at his 70th year, the title of Arnold Professor remaining. His coming to New York in 1930 brought him into the more important councils of botanists and in particular into the deliberations whereat the laws of nomenclature were discussed. With the title of Vice-president of the Congress he took the chair at Cambridge in the nomenclatural discussions of the Fifth International Congress (1930) and five years later presided over the section of Taxonomy and Nomenclature at Amsterdam in the Sixth Congress. He was an Honorary member of many European as well as American Societies. Always helpful, his administrative career was already well established when the Linnean Society gave to him the Linnean Medal and in giving it the President aptly said of him that no botanist better represented the spirit of international good will and co-operation than he.

I have given the year 1920 as that when Merrill commenced to take great interest in the flora of the Pacific. In it he was roused to a rejoinder against a claim that *Hibiscus tiliaceus*, the common source of caulking material throughout the Pacific, had been brought by the Polynesians from America. In 1930 he protested against other claims of pre-Columbian diffusion between America and Polynesia. In 1933 he argued in the Fifth Pacific Congress for the complete independence of the Old and New Worlds in regard to cultivated plants. In 1940 he wrote on Man's deliberate and accidental introduction of alien plants into Polynesia and of the modern mix-up being of modern man's making and of the place in evidence for that afforded by the records of the earlier European voyagings. But he took the occurrence of the American Sweet Potato in the Pacific as evidence that there had existed Polynesian voyagers who in an adventure reached the American coast and had the luck to get home again alive and with the Sweet Potato in their possession, adding he assumed that they would transfer a few weeds as well as the Sweet Potato. In 1951 being in London he became deeply interested in the plants collected on Captain Cook's voyages, at first from a taxonomic point of view and then from the anthropological. The weeds offered evidence parallel to that to be had from the cultivated plants of Man's wanderings ; and he started to write his last book—*The Botany of Cook's Voyages*—which, along with the taxonomic information that he had to give, was to bring up to date from 1940 his position regarding the dispersal of plants. He wrote the book with great difficulty, being increasingly ill. He stoutly rebutted new claims of diffusion and in regard to himself moved just a little away from accepting a thought-out transfer of the Sweet Potato, similar to that from the eastern Pacific islands to Hawaii, New Zealand and elsewhere.

A critiscim of diffusion-claims had indeed become desirable.

I. H. Burkill.

Chinnakavanam Tadulingam Mudaliar, F.L.S., was born in October 1878, at Madras. He stood first in the B.A. Examination of the Madras University in 1900, and later got training under Dr. (later Sir) Alfred Bourne, F.R.S. At first he was the Systematic Botanist in the Agricultural College, Coimbatore, but later he was appointed its Principal, having joined the Madras Agricultural Service in 1901. Mr. Mudaliar, along with the late Mr. Rangachari, organized the Madras State Herbarium and Research Institute at Coimbatore. He was also a popular teacher and was very much loved by one and all. After his retirement in 1933, Mr. Mudaliar took a keen interest in the civic affairs of Madras City, and served as a Councillor for the Chepauk Division for 15 years. He was elected as Mayor in 1942. He was the President of the Co-operative Milk Supply Union, Ayyanavaram. Mr. Mudaliar died on Wednesday, 13 October 1954 at Madras at the ripe age of 76 years. He will ever be remembered for his service to Indian Botany and as a very generous and pious person, who would do his best to help those who approached him at the time of dire necessity. He was elected a Fellow of the Society in 1915.

Y. Bharadwaja.

Sir **David Russell**, Kt. LL.D., F.R.S.E., F.S.A., F.L.S., F.S.A.(Scot.), J.P., died at Silverburn, Leven, Fife, on 12 May 1956. He was born in 1872 and was a son of David Russell of Silverburn. He was educated at Clifton Bank, St. Andrews and at the University of Edinburgh. He became Managing Director of Tullis, Russell and Co., Paper Makers of Markinch. As well as his considerable business interests, he had a deep concern with matters of religion and education, particularly science. His personal studies were mainly in the field of archaeology. He worked in Istanbul and the report on his excavations is contained in *The Great Palace of the Byzantine Emperors* (1947) of which he was the editor. His practical interest in education was early appreciated by the University of St. Andrews which conferred on him its honorary Doctorate of Laws, in 1922. His services to a wider community were fittingly recognized when a knighthood was bestowed on him in 1946.

Scotland in general and the University of St. Andrews in particular have cause to remember with gratitude the many, generous and wise benefactions made personally and through the medium of the Walker Trust. Sir David was a great benefactor of the Church of Scotland, in particular giving active help towards the restoration of the abbey at Iona. Within St. Andrews University his services were of inestimable value. He served as Chancellor's Assessor on the University Court from 1938 to 1955. The University was able to draw freely on his time and experience in any matter which touched closely its interests. He gave great help with many building plans. When the fabric of St. Leonard's Chapel was restored with the help of the Pilgrim Trust, Sir David furnished it as a memorial to his son Patrick, a former student of the University, who died of wounds in 1944. He provided funds to set up chaplaincies in the Dundee and St. Andrews colleges of the University. He established Residential Scholarships and Exhibitions for undergraduates. He supported University research in many fields, notably in marine biology and in botany.

Sir David had a great love of plants and gardens. Till his health failed, he was a regular and most welcome visitor to the University Botanic Garden at St. Andrews. He became a Fellow of the Botanical Society of Edinburgh in 1938, serving on its council from 1942 to 1945 and acting as a Vice-president from 1945 to 1947. He was elected a Fellow of the Royal Society of Edinburgh in 1930, serving on its council from 1940 to 1943 and as a Vice-president from

1943 to 1946. He was elected a Fellow of the Linnean Society in 1937. He took an active part in the formation of the National Trust for Scotland, of which he was a Vice-president at the time of his death.

Sir David is survived by Lady Russell, one son and two daughters.

J. A. MACDONALD.

Professor **Carl Jørgen Wesenberg-Lund**, the well-known Danish freshwater biologist, died on 12 November 1955, nearly 88 years old. In 1897 he founded the Freshwater Biological Laboratory of the University of Copenhagen, and directed it for more than 40 years.

Wesenberg-Lund was born in 1867 as the only son of C. T. V. Lund, Captain in the mercantile marine. When the boy was a couple of years old, his father died. When he reached the age of 11, his mother moved with him to the small town of Hillerød in North Sealand and here Wesenberg-Lund grew up and roamed about the neighbourhood with its numerous woods and lakes. He was educated at the grammar school of the town and, after finishing school, he studied at the University of Copenhagen intending to take a M.Sc. degree in zoology. Among the professors of the University, the noted ecologist and botanist Eugen Warming, especially influenced Wesenberg-Lund and inspired him with interest in these branches of learning.

As an undergraduate and young graduate Wesenberg-Lund for some years studied bees and wasps, and published two papers on these animals. Throughout his life he retained his interest in the Hymenoptera and wrote several papers on them in popular scientific works.

Soon, however, he turned his attention to freshwater-biological investigations, and in 1895 he wrote a prize paper on the Bryozoa, Spongilla, and Rotifera, for which he was awarded a gold medal. Enlarging the section on Denmark's rotifers into a dissertation, he became Dr. Phil. in 1899.

After having been for some years assistant to Dr. J. E. V. Boas at the Zoological Laboratory of the Royal Veterinary and Agricultural College, he was able in 1897 to found a small freshwater-biological laboratory. It received support from the University of Copenhagen, the Danish State, and more especially from the Carlsberg Foundation. The laboratory consisted of a deck-house from the expeditionary vessel *Ingolf*. It was erected by the Fure Lake, north of Copenhagen.

After the establishment of the Freshwater Biological Laboratory, Wesenberg-Lund devoted himself to extensive investigations on the bottom deposits and plankton of lakes. It was of decisive importance to him, both as a scientist and as a man, that in 1899 he was able to resign from his position as assistant at the Royal Veterinary and Agricultural College, the Danish State granting him an annual subvention and a personal salary. With these subsidies and a grant from the Carlsberg Foundation, the way was open to him for an investigation of nature unhampered by any heavy official duties. For more than 50 years he could now devote himself to his studies, giving full vent to his vigorous powers of research.

In the first place a folio work in two volumes on the plankton of the Danish lakes came out in 1904–08. Plankton had been gathered in 9 lakes, at all seasons, and described and depicted. Of the results, the information about the so-called temporal variation of the plankton must primarily be emphasized. In summer the plankton organisms show a tendency to increase the size of the organs which must be supposed to counteract their sinking in the water. Since the variation was considered to take place at the same time and in a uniform manner for organisms belonging to different systematic groups, Wesenberg-Lund drew the conclusion that it must be due to the variations of an external factor, the temperature, and the consequent accompanying varia-

tions in the density of the water. A little later the German investigator W. Ostwald argued that it must be the much more marked fluctuation of the viscosity of the water which must be the releasing factor of the temporal variations. These views have been combined under the name of the Ostwald-Wesenberg-Lund buoyancy theory.

While working with the plankton problems, Wesenberg-Lund made a journey to Scotland where the deep-sea explorer Sir John Murray was directing the large-scale investigation and charting of the deep Scottish lakes. The stay resulted in a paper by Wesenberg-Lund in which the Danish and Scottish lakes were compared (1905). Another journey, presumably of even more importance, took him to Switzerland. Here Wesenberg-Lund had the opportunity of staying by the Lake of Geneva with Professor F.-A. Forel, the investigator who has given limnology its name, and who wrote the first limnological monograph.

With the Furesø laboratory as a base, studies in various fields were started. Wesenberg-Lund detected the existence of a glacial-marine relict fauna in Furesø; he also studied the pond plankton in the neighbourhood, and the animal community of the surf shore of the lake. In collaboration with the chemist J. N. Brønsted a chemico-physical investigation of the water in Furesø was made (1912), a work in which for the first time the chemical and thermal conditions of a Baltic lake were subjected to close study.

As a fitting conclusion to the work on the Furesø, comprehensive studies of this lake were undertaken with several co-workers (1917). Bathymetric charts of the lake were made, its plant zones were mapped, the distribution and variation of the molluscs were precisely described, and a survey was made of the qualitative composition and occurrence of the rest of the lake fauna.

Wesenberg-Lund now began to study insect biology in the environs of the Furesø. This fact became of special importance because insect biology was a domain where his great gifts as a field zoologist, his pleasure in observing and describing the animals' mode of life, and his ability to record his observations by means of beautiful drawings, gave the richest results. He wrote about the net-spinning caddis fly larvae, about the egg laying of dytiscids, about the different types of dytiscid larvae, from burrowing and creeping to floating forms, and about the respiration of imagines. The pairing and egg laying of the dragonflies, their flying periods, growth, and overwintering were likewise dealt with.

Studies of mosquitoes occupied Wesenberg-Lund for a number of years. In his main work in 1920 on this subject, 25 species are described, and it is related how the individual species live under definite natural conditions. Further, the life-cycle of the animals is described. The work includes more than 20 fine plates drawn by Wesenberg-Lund.

Among other papers on the group is that on the curious *Mansonia* larva (1918), whose siphon has been transformed into an instrument for boring into submerged plants, so that the larva can use the air in the plants for respiration.

Most of these insect studies and several other papers were printed in the *Internationale Revue der gesammten Hydrobiologie und Hydrographie* in Leipzig. In this way they were quickly made known in interested circles and obtained wide recognition.

As the surroundings of Furesø became year after year more built over, the laboratory was moved in 1911 to Hillerød, 35 km. to the north of Copenhagen. After being lodged in a flat for a number of years, the laboratory acquired its own building in 1930, the expenses being defrayed by the Carlsberg Foundation. In 1922 Wesenberg-Lund was appointed Professor of Freshwater Biology at the University of Copenhagen. He has given an account of the development of the laboratory in a little book entitled *Ferskvandsbiologisk Laboratorium gennem*

40 *Aar* (The Freshwater Biological Laboratory through 40 years) (1940), which also tells us about his chief scientific results and contains a bibliography.

The above-mentioned insect studies and many scattered observations on other insect groups were collected into a substantial book on *Insect Life in Fresh Waters* (published in Danish in 1915). It is written in an entertaining, captivating style and in conjunction with an earlier Danish book on animal life in field and wood, is perhaps the book that has made Wesenberg-Lund most popular among Danish readers. It has influenced many younger zoologists and has no doubt contributed to attract many new students to the study of zoology in Denmark.

Wesenberg-Lund's power of fascinating his readers was probably especially due to the fact that he himself was so engrossed in his subject and had so sensitive a mind that it was natural for him to clothe his descriptions in striking, almost poetic language. To this must be added his inclination for and power of viewing topical biological phenomena in a wider perspective, of drawing comparisons with other phenomena of life, even with those of human life. These qualities made Wesenberg-Lund a well known feature-writer for the daily press and were a great asset in his work for nature conservancy.

Wesenberg-Lund's interest in the preservation of nature developed as a matter of course out of his work in nature. Owing to the growth of the population and to cultivation, the Danish landscape underwent such changes that it was only reasonable for a naturalist to try to rescue what could be rescued. Wesenberg-Lund carried out a great amount of work, particularly for improving the conditions for birds of prey, for swans and other natatorial birds. Further he initiated a campaign against pollution and other forms of destruction of fresh waters, and he wrote numerous articles in the daily press about the cruel methods of hunters, the effect of silviculture on animal life, etc.

Wesenberg-Lund's lively style, his intimate life with nature, and his intensive research work were also important factors in his teaching of students on excursions and in freshwater-biological classes. They felt that they were in the presence of a remarkable personality. They saw that he had something to give them beyond what was in the text-books. They were inspired by his ardour, his own observations of nature, and his enthusiasm as an investigator.

After concluding his work on insects, Wesenberg-Lund returned in the twenties and thirties to the investigation of rotifers (1922–30), daphnids (1926), and other plankton organisms (1934). For a number of years he especially studied the trematodes, the many types of planktic cercaria being of particular interest to him. They were shown to be adapted in many different ways to swim or float in the water, and he made numerous observations on them.

Towards the close of his time as professor, Wesenberg-Lund summed up his own papers and those issued from the laboratory in two text-books, *Biologie der Süsswassertiere* (1939) and *Biologie der Süsswasserinsekten* (1943), which, however, are based also on an extensive knowledge of the literature in several languages. These large text-books, which are beautifully illustrated and bear a strong impress of his personality, contain a detailed treatment of the biology of all the lower freshwater fauna. At the same time they give a thorough well-balanced account of Wesenberg-Lund's whole life-work. Both books have had a wide circulation.

An attempt to characterize Wesenberg-Lund as a scientist must first of all emphasize that he was an eminent and acute observer, an investigator of nature in the true sense of the word. Next must be mentioned his great productivity, his power of combination, and his special inclination for and capability of penetrating into biological problems. His feeling for the beauties of nature and his power of describing them must also be stressed. Finally his unremitting industry must be emphasized, the fact that he was always entirely engrossed

in the subject he was dealing with, always collected material for the express purpose of publication, and never—apart from his work with nature conservancy —occupied himself very much with administrative business, club life, congresses or the like. Such things he considered mainly as disturbances.

As soon as a paper had been sent to press, Wesenberg-Lund continued with studies for the next. He never relaxed. A quiet and happy family life was a prerequisite for him, and was the foundation for this way of living. His wife—Mrs. Jenny Wesenberg-Lund, née Knudsen—was an invaluable support to him throughout his life. She conducted her household with the main purpose of creating the most peaceful working conditions for her husband.

Wesenberg-Lund's method of research was primarily direct observation of nature, secondarily direct observation of the organisms in the laboratory and under the microscope without any elaborate technique. During his work out-of-doors he used simple nets and scrapers, no complicated quantitative methods of capture. His aim, and the means he employed to attain it, was direct contact with nature.

At the death of Wesenberg-Lund, Denmark lost a naturalist who was able to subject his own observations and the information gathered from the literature to so full and suggestive a treatment that his treatises became finished of form, impressive in bulk, and highly inspiring. His papers have been very frequently quoted, and he enjoyed a very high reputation in the biological world, both on account of the volume of his works and their wealth of fresh observations, and because of their numerous new ideas and considerations. Hence he received a great many foreign and Danish marks of honour. Thus he was an honorary member of the Queckett Microscopical Club (1923), corresponding member of the Zoological Society, London (1926), foreign member of the Linnean Society of London (1938), and member of the Royal Danish Society of Sciences (1918).

Wesenberg-Lund's scientific activities have brought honour to his country. His name will live, and he will be remembered as the indefatigable investigator, the great lover of nature, and the eminent biological observer.

Kaj Berg.

THE DISTRIBUTION, ECOLOGY AND TAXONOMY OF PORPHYRA ON SOUTH AFRICAN COASTS

By Wm. Edwyn Isaac.
Botany Department University of Cape Town.

(With 2 text-figs.)

Porphyra is widely distributed on the shores of South Africa from the northern border of the Union of South Africa on the west coast to about 31·5° latitude (Port St. Johns) on the east coast. To appreciate the implications of this wide distribution range it must be remembered that while the coastal waters of the west coast are influenced by the relatively cold Benguela current the coastal waters of the east coast and south coast as far as Cape Agulhas are subjected to the direct influence of the warm Agulhas current. Cape Agulhas is the most southerly point of Africa and in this region the continental shelf is extensive forming the Agulhas Bank. This Bank deflects most of the Agulhas current waters back eastwards but the deflected water moves eastwards at a higher latitude than the Agulhas current in its south-westward flow. West of Cape Agulhas and immediately east of the Cape Peninsula lies a large bay—False Bay. Due to local conditions the sea temperatures of False Bay are abnormally high foi its geographical position, being higher than the sea temperatures immediately west and east.

The known range of average annual temperatures for the region west of Cape Agulhas but excluding False Bay is of the order of 13·0° C. to 15·5° C., while the known range of average annual temperatures for the coastal waters east of Cape Agulhas is of the order of 17° C. to 22° C. The available temperature data for False Bay are still less adequate than those for the east and west coasts but the highest known average annual temperature is 16·6° C. (Muizenberg) for the north-western corner of this bay. (Isaac, *Geogr. Rev.*, 27, 1937.)

In regard to the development of the *Porphyra* association four general regions can be distinguished (fig. 1).

(1) The west coast north of Cape Point where the *Porphyra* association is dense, extensive and luxuriant.

(2) A region of good-to-moderate development from Cape Point to Cape Agulhas but excluding False Bay.

(3) Moderate-to-poor development from Cape Agulhas to Witte Elsbosch.

(4) A region where the *Porphyra* association is absent and where *Porphyra* plants are scarce or almost absent. This region extends from Port Elizabeth to Port St. Johns. In the latter only a few plants may be found after an hour's search. Further information is needed for the region between Witte Elsbosch and Port Elizabeth.

It will be seen that there is a general decline in luxuriance of the *Porphyra* association from west to east. In this general sequence of change there is one major break—False Bay. If the geographical sequence were unbroken False Bay would show a good-to-moderate development such as occurs from the eastern limits of False Bay to Cape Agulhas. In fact the condition of *Porphyra* in False Bay is similar to that found between Agulhas and Witte Elsbosch.

Porphyra occurs most typically on South African coasts from high water level of neap tides to about mid-tide level. In places it extends above high water level of neap tides. Isolated plants and plants at the upper limits of the *Porphyra* association successfully withstand losses in weight of the order of

70 to 75 per cent of fresh weight. Higher losses, even of the order of 80 per cent, have been recorded. On very hot days losses in weight of the order of 70 to 75 per cent are widespread.

Although a high intertidal level would seem to imply a tolerance of wide salinity variations, *Porphyra* is rarely found in such habitats as rock pools. It sometimes occurs in the upper sub-littoral where it may be epiphytic on kelps and it also grows in places where it is subjected to reduced salinity. Thus it is clearly euryhaline as well as being eurythermal.

Fig. 1.—Map showing the relative luxuriance of *Porphyra capensis* on different parts of the South African Coastline. Inset, the coasts around False Bay shown on a larger scale.

On the coasts of South Africa *Porphyra* presents a wide range of form, size and colour. In this plexus three major but overlapping groups can be distinguished. The typical west coast form is dull purple in colour, reniform to cordate and relatively large with a maximum dimension of as much as 2 ft. A smaller, pale-coloured form which frequently shows a twisting and curling of the thallus, occurs in warm waters and above high water level of neap tides on the west coast. There is also a linear or lanceolate form which occurs in cold and moderately warm waters. All these forms are monostromatic and have a small attachment disc consisting of rhizoid-like outgrowths of cells of the basal part of the body. Kützing represents *P. capensis* as having a short

definite stipe, 1–2 mm. long (*Tabulae Phycologicae*, 19, pl. 86). A stipe can be distinguished in some specimens of South African *Porphyra* but it is not a constant feature of any distinguishable type.

It has been noted that cold-water *Porphyra* plants growing above high water level of neap tides approximate in their external characters to a greater or lesser degree to the *Porphyra* plants of warmer seas. South African *Porphyra* plants can withstand heavy water loss but if exposed too frequently and too long to water losses exceeding two-thirds of the fresh weight there results a stunted growth, lighter colour and a tendency to curling of the thallus. Conditions of frequent and heavy water loss occur in cold seas at the upper limits of the vertical distribution of *Porphyra*. The occurrence of the same type in warmer waters is less easy to explain. Overall water loss, however, is likely to be heavier than in plants of cold waters for at least two reasons. Firstly, there is much less mutual protection from the massing together of plants in dense communities, the plants occurring singly or in small clumps. This less luxuriant growth is to be related to higher sea temperatures. Secondly, land temperatures and intensity of insolation progressively increase eastwards from Agulhas and fogs, which are a feature of the west coast, are absent from this region. Such considerations are of considerable importance when it is remembered that the *Porphyra* plants remain emersed (i.e., uncovered by the sea) for 60 to 70 per cent or more of the year. The surprising fact is perhaps that these plants survive at all under conditions which are so far removed from those for optimum development. When conditions deviate too far from the optimum, however, stunted growth, lighter colour and curling of the thallus occur whether the unfavourable conditions are those of high inter-tidal levels on cold water shores or occurrence on shores of warm seas. It has been possible to induce the formation of pale, tufted plants from large dark-coloured cordate plants by transference of a rock with attached plants from lower to higher intertidal levels.

The question arises whether South African *Porphyra* plants constitute one or a group of species. Although there are types showing decided differences in external appearance, transitional forms occur. From a careful reading of the relevant parts of Kützing's *Phycologia Generalis* (1843), his *Species Algarum* (1849) and Agardh's *Till Algernes Systematik* (1883) it appears certain that these earlier algologists dealt with the same plexus of forms which are dealt with in this communication. Kützing recognized two species: *Porphyra capensis* and *P. augustineae*. Delf & Michell (*Ann. Bolus Herbarium*, **3**, 1921) recorded two further species for South Africa from the herbarium material of Tyson's collection at Cape Town University. These additional species were the European *P. laciniata* and *P. vulgaris*. Thus they record a total of four species for South Africa but they comment that: "The species of *Porphyra* are somewhat ill defined, and require further investigation". (*Ibid*, p. 102.) Agardh on the other hand, maintained that the various types of South African *Porphyra* were forms of one species. This view had also been arrived at independently by Cotton & Setchell (private communications) while material from Port Elizabeth was identified as *P. capensis* by Kylin (*Kungl. Fysiogr. Sällskap Handl.*, N.F., Bd. 49, No. 8, 1938). *Porphyra* has such a simple morphology that but few characters are available for the delimitation of species and the reliability of these characters for taxonomy needs scrutiny. In correspondence Setchell emphasized the constancy of the characteristic form of the reproductive organs in South African *Porphyra* plants. In the attempt to find characters useful for species delimitation it was decided to investigate the shape of the reproductive organs, number of spermatia and number of carpospores in relation to external form.

A short digression is here necessary in relation to terminology. In 1954 Drew published a paper in the *Annals of Botany* on the *Conchocelis*-phase in culture of *Porphyra umbilicalis* (L.) Kütz var. *laciniata* (Lightf.) J. Ag. This paper contains a critical survey of literature dealing with the life history of *Porphyra*. On the basis of this survey Drew concluded that critical evidence of fertilization and meiosis is lacking for *Porphyra* and that until such evidence is forthcoming the term "carpospore" and by implication "carpogonium" should be avoided. For the present, however, these terms have been retained.

Although the majority of South African *Porphyra* plants of all types are either male or female, monoecious plants occur. The matter needs further investigation but monoecious plants do not appear to be uncommon. In one sample of 46 plants collected at Llandudno on the west coast of the Cape Peninsula, the male and female plants were present in about equal numbers and about a quarter of the sample were monoecious plants. The reproductive organs form a peripheral zone around the thallus especially at the upper end. In the monoecious specimens examined the antheridia and carpogonia occurred

FIG. 2.—Diagramatic representation of monœcious plants of *Porphyra capensis* showing clear delimination between "male" and "female" sectors of the plant body. (Drawing by Miss J. M. Graves).

in different parts of the thallus, the dividing line being more or less well marked. There may be one male and one female part of the thallus (fig. 2A) or one or more strips of one sex alternating with the other (fig. 2B). The dividing lines can usually be traced as far as the holdfast.

It was found that throughout the various size, colour and form variations of South African *Porphyra* the narrow elongated form of the antheridium and of the ripe carpogonium remained constant. The number of carpospores varied from 16 to 32 in four vertical rows and the number of spermatia varied from 64 to 128 in eight vertical rows. No consistent relationship was found between variation in the character of the thallus and variation in the number of spermatia and carpospores.

On the basis of the available evidence there would seem to be no justification for attempting to separate out the plexus of South African *Porphyra* plants into

a number of distinct species. In the absence of consistent differences in structural features in relation to the different form types, together with the existence of intermediate forms, one is constrained to agree with Agardh in recognizing one species of inter-tidal South African *Porphyra*. Agardh retained the name *P. capensis* for the plexus of South African forms. The name of the species is written as *P. capensis* Kütz., but in view of the conclusion arrived at and the fact that under this name Kützing referred to only part of the plexus of forms referred to as *P. capensis* by Agardh, the name should be written *P. capensis* Kütz. emend Agardh.

The investigations reported here were carried out by the author assisted by Miss Judith Graves and were in part made possible by financial support from the C.S.I.R. of South Africa to which body we offer thanks. It is intended to publish fuller papers in due course.

TAXONOMY AND TROPICAL PLANTS

By E. J. H. Corner.
Botany School, Cambridge.

Tropical botany is entering a new stage. From a period of exploration it is passing to that of self-determination. It began with the voyages of discovery, and it has lead to the great herbaria of northern countries and to a few tropical botanical gardens, which until recently have been administered mainly from Europe. A little while ago it seemed well-fostered. Now it is beginning to stand, with frailty in most cases, on what I will call sympatric support. I am concerned with how we may encourage this independence. No other science should derive more from its tropical aspect, for the majority of plants and most problems of botany are tropical, but we have only to open the text-books to see how deficient they are. And, with the multitude of experimental problems arising almost daily to detain botanists in their laboratories, this deficiency may continue, if there is no call or occasion to visit the tropics. In other words, tropical botany, in the present tenor of the world, may fail. It is not indifference which I fear, but the axe.

Foremost in tropical botany must come taxonomy. In this country we can do botany without botanical names: I would almost say without plants. But, in the tropics, with so many unfamiliar plants and, practically, no audience, the botanical name is the only symbol. From the many volumes on tropical floras, one would suppose that here was no difficulty. In a sense it is true. Probably over three-quarters of tropical flowering plants have been described, and all the common ones. But it is also mistaken. We all know how much revision is needed. The correlation of adjacent floras, the continual discoveries, and the incorporation of new methods of classification continually render the older works obsolete. Bigger and better floras are required.

But let us pause to consider a tropical flora. It runs to many volumes. It is terse and technical. It stands, therefore, in the library of the institute which can afford it and which can afford to employ botanists to interpret it. It reaches very few. Between Belem-do-Para and Quito, for over two thousand miles of the greatest tropical forest on earth, where every form of exploitation is agitating to destroy it, there is just one other institute so equipped, and that is but a wing of the large Agronomical Institute of Belem. Another was begun at Manaus, but it ceased long ago and its library, that of Barbosa Rodriguez, is locked up in a room in the state school of Pedro II, where no one can interpret it. No botany is taught in the schools and there is no indigenous botanist,

apparently. Of course, botany is part of civilization, and botanists congregate at its foci, but there is another good reason why there is no botany where the floras are the richest. The books on the floras have been written for use in the herbarium, and not, or rarely, for use on the spot. For instance, most large and conspicuous monocotyledons are not difficult to recognize or identify until one comes to use a flora. Strychnine fruits are common and distinctive, but you cannot get at them through floras. In Malaya I knew a lot of dragonflies, but I could not get at them through the monograph, which treated them as palps and genitalia. The fault is not botanical. We need two kinds of book to convey tropical taxonomy, and so to introduce tropical biology. We need the profound work for excogitation in the herbarium or museum, and we need the introductory work which, by way of common genera, artificial keys based on living features, drawings, and photographs without profound dissection, will lead the student, amateur and biologist to the first real appreciation of tropical nature. This sort of work is, in fact, essential if tropical botany is to become sympatric. It is essential if the public and its ministers are to become aware of their responsibility for nature preservation. And it is, I think, a reflection on the narrowness of overseas education that there are so very few of these introductory works in tropical countries. When I meet students from thence, I am worried by their ignorance of their own lands. They come here to learn, when we have gone there to learn. Yet never, in Malaya or in the Amazon region, did I meet a villager or peasant, if you will, not interested in things biological. The sagacity of native collectors is well known, admired, though seldom understood. I have listened often to natural history told by the old women, and I have seen young men and children leave off play to come into the forest or along the shore. People, deemed simple and feckless, become intent on natural history. The tropics are full of potential biologists, but the system of education is so dead against them that their inclination is stifled. I have always said "worms and bacteria before algebra and Shakespeare", but if there are no introductory taxonomic works, what worms and what bacteria? What flowers, what fish? It is the lack of these books which makes biology so difficult to teach in the tropics, and which makes me so uncertain about the future of tropical biology. We may suppose that a classical foundation, followed by mathematical, physical and chemical higher education, should precede a course in biology, but where the aeroplane and radio have taken over directly from the donkey and the bullock and canoe, there are many short cuts. It is an immense pity that the human mind should be prevented from getting at its most wonderful subject.

Some may think this kind of publication unbecoming. In a way it should be the alpha of taxonomy. It needs but to struggle with the nomenclature of common tropical plants to discover this error. And, then, to treat them as living things, leafing, flowering and seeding in the unremitting tropics, will tax one's knowledge, powers of observation and research, and one's whole ability. Most information must be obtained first-hand, which is why there are so few of these alpha-books for the tropics. I wish young men and women from the tropics would come here not to learn how to become scientific technicians, but how to develop biological education in their own lands where they are assuming responsibilities without the means of education. Directors of education should demand these alpha-works, and it would be a far-sighted body that could lay out funds to help their completion.

Now these introductory works are needed not only for political countries, but for the tropics in general. We need an introduction to the common palms of the world, so widely grown in the tropics. We need such general introductions for the bamboos, the pandans, and the other large monocotyledons of widespread cultivation, as we do for the tropical vegetables and, even, for the

fruit trees. We need also an introduction to the most wonderful and ornamental family of dicotyledons, namely the caesalpinioid trees, shrubs and climbers, on a world, not a territorial, basis. In mycology, an introduction to a hundred common polypores of the tropics would be more use than any erudite and, at present, absolutely unattainable mycological flora. Perhaps some learned and wealthy foundation can be induced to see the wisdom of such outlay. It would repay horticulture, agriculture, general education and national pride, and it would lay the sure foundation for the international responsibility of nature preservation.

I must pass to the beta-taxonomy, which is the comprehensive flora or fauna. It raises very different problems. A country is part of a region, which, in turn, is part of the world. A local flora should be an excision of the world-flora. There are world-monographs of many plants, but they are variously out-of-date. We are at the stage of making new regional floras without, in most cases, modern world-monographs. If they are to be the new beta-floras, new world-monographs will require gamma-floras. The course adopted is dictated by economic expediency: tropical governments will not finance world-monographs, and we limp along. Then, when we reflect on the time taken to produce the new British Flora, the immense task of the tropical flora will be realized. There is at least a tenfold increase of taxa and synonyms: the collections are distributed over the main herbaria of the world: large parts of the region to be treated are unexplored botanically, and no part is thoroughly and critically explored: there are few, if any, botanists on the spot: most information must come from dried specimens without adequate field notes: and to make amends requires an expedition. Why, indeed, go to this great labour if there is practically no one in the tropics to use the flora? Would not the alpha-works, the foresters' manuals, and like extracts suffice? Would it not be better to wait for the world-monographs?

This problem is bound up with the progress of the scientific societies and institutions of extra-tropical countries concerned with world-biology. Regional floras are produced as the special work of the institute matures. Their value to biology in general and their scope is far beyond the immediate requirements of the tropical country. Their importance to botany is so well-known here in London that I need not try to explain. But two points are worth mention. Very few, if any, herbaria in the tropics are large and representative enough for such undertakings. Calcutta, Bogor, Singapore and Rio de Janeiro come to mind, and they present problems of staffing, library, and, indeed, of the preservation of specimens, which undoubtedly suffer through the heavy poisoning which is necessary. As far as I can see, no tropical country by itself has the means of co-ordinating a regional flora: and, as its taxonomic work becomes more sympatric, its herbarium will tend to become as limited. The tropical floras and the world-monographs must devolve upon the great herbaria of the north temperate region: there, only, are adequate material from all over the world, adequate libraries, and the possibility of funds to employ the botanists. I plead merely that the world-monograph should not be overlooked.

I now come to the part of the universities. The great days of Benthamian sufficiency are over. We must depend more and more on the salaried scientist, while hoping always for the ripe maturity of the retired: the harvest of taxonomy is ever late. The opportunities for a taxonomic career are few, so that one cannot expect the modern university to stress this vocation, but the taxonomic opportunities open to any biologist are immense, and therefore the subject must be adequately represented. Concerning the teaching of botany four things impress me. There is, as I have mentioned, the poverty of text-book and theory both in a knowledge of tropical plants and in any realization that there can be such new knowledge. Then there are many other disciplines

than taxonomy to attract the student. These disciplines, thirdly, must be incorporated in curricula, with the effect that taxonomy, which was the only discipline, is always receding. There is no doubt that their forefathers, emerging from the university, knew more pure taxonomy than do the modern botanists. Lastly, there is a gulf between taxonomy and most other disciplines.

Consider *Senecio campestris*. Its ecology is interpreted with that of other chalk-loving plants of Britain ; in reality, its ecology is derived from the world-wide, tropical and subtropical genus *Senecio*, and is only analogous with that of other plants of its association in Britain. The truly scientific ecology, that is the homologous ecology, of *S. campestris* in *Senecio* is unknown and unthought about. *Erica* and *Vaccinium* are interpreted as acid-loving plants, but their ecology is homologous with that of the tropical and subtropical epiphytes of their families, rooted in the acid humus of ants' nests. Only taxonomy on a world basis, which must be mainly tropical, can teach the true homologies of plants. We all know the trouble in finding general features of stomatal behaviour, and I venture to suggest that the reason is that plant physiologists as yet have no appreciation of the value of the taxonomic method of strictly homologous comparison : we compare geraniums with cherry laurels because horticulture, not science, has brought them together. In this way I see taxonomy as the hall of wisdom.

In the old days the student worked through the pocket-lens characters of the families of the world. If we continue in this way, he will not get very far through sheer lack of time. The old order of taxonomic teaching must change, if it is to be progressive. At present it is receding or being displaced by partial aspects such as cytogenetics or experimental cultivation at the specific level. They are but other instances of how readily taxonomy can be displaced. Should we be alarmed? I think not, for the following reasons.

The taxonomist is privileged. He introduces the new organisms to biology. So long as descriptions and comments are traditionally formal, his announcements will be passed over by general biology. This is, in fact, why text-books are so generally heedless of tropical plants : their descriptions are not profound enough for the other disciplines. Text-books know the seeds of *Ricinus*, but how to employ its leaves, flowers, fruits, vascular structure, habit or habitat, they do not know because such things are Euphorbiaceous and recondite in taxonomic monographs. The taxonomist can always contact his colleagues in the other disciplines. To acquit himself, however, he must be widely grounded in biology, and this is exactly what we hope is happening to the university student. From a one-discipline man of last century, he is becoming a many-disciplined, which is exactly what is needed for the greatest synthesis of taxonomy, namely the evolution of natural history.

How are we to train a tropical taxonomist? It must be largely a matter of post-graduate research. In the advanced courses for the honours degree I have given up teaching the pocket-lens characters : they are well set out in the modern systematic books, and I expect the student from his previous training to know how to use those books himself. Other disciplines require that the advanced student should read original papers : I prefer that the taxonomic student should make original identifications for himself by means of the collections at the University Botanic Garden, because taxonomy is practice and ever practice before much benefit, other than confusion, can come from reading. I prefer to lecture on a few of the large families, such as Leguminosae, Palmae and Gramineae, to illustrate the precision of thought which can be obtained on taxonomic lines from the comparative, or systematic, studies of the other disciplines. Thereby the overwhelmingly tropical element is introduced, and the student's general knowledge can be enlisted. In practicals it is necessary to teach how to make the fullest use of the binocular dissecting microscope,

which is the great advance of recent years upon the pocket-lens, for it brings the student into the microscopic realm : and I teach how to collect and make proper field notes upon large plants. It is one thing to collect, press and describe *Poa annua*, and a very much more difficult matter to deal with a tree, liane, palm or aroid. We all know how deficient are the field notes and herbarium specimens of such plants, and the rising generation should do better.

The training of the student now passes to the post-graduate stage of the Ph.D. In England we have been handicapped in taxonomic research for this degree by the fact that our universities are separate from the two great herbaria, but a very welcome advance has occurred in all such international work : it is the ready loan of material. It is possible to borrow much, if not all, of the material needed for the revision of a genus with the effect that, in Cambridge, we can now employ more fully the very rich botanical library of the University and, indeed, cut open pages for which there had been no demand. I have hopes that with students who are taxonomically inclined, we can undertake some of the world-monographs which are needed to supplement regional floras. I have even a greater hope that, through co-operation with botanical institutes in the tropics, the research student may be able to spend some of his time studying the living plants. A scheme of this sort is under consideration in Malaya, and, as Mr. Purseglove said to me, if a research student can visit the tropics, even for a short time, he may acquire a lasting interest of benefit to tropical botany. There is too much coming from the tropics to study in Europe and North America, and far from sufficient means to travel and study the other way. Access from the northern botany schools to the tropics by interchange of lecturers or research students would help, perhaps more than any other means, this intermediate stage in setting tropical botany on its own footing.

Hitherto I have dealt with the botanist. We must not forget the plants. Fifty or a hundred years ago, when so many basic collections of tropical plants were made, there must have been readier access to the forests than now. In the interval the forests have been cut down for greater and greater distances from the towns, until it is now difficult to find any within working distance of a botanical institute. What profits a science if it lose its subject-matter? We have paid too little attention in this country to the ever more pressing need for nature preservation in the tropics. Certainly plants can be grown in botanical gardens, and it is a duty of taxonomists to indicate native plants which should be thus secured, but botanic gardens cannot hold everything and they cannot supply the natural environment for the prosecution of scientific natural history. I suppose that the most favourably situated place for tropical botany could be Rio de Janeiro, where the Federal Government has turned the mountain-sides into the splendid nature-reserve of Tijuca. On the other side of the world is Penang Island with fascinating possibilities, if there was a body that could press for the need of a field station to supplement the erstwhile botanic garden. In Indonesia the vigour and foresight of the Dutch forester, S. H. Koorders, established a great system of nature reserves which are being maintained as well as can be expected under the difficult circumstances. On Singapore Island there are also a few nature reserves of considerable value. Trinidad is, I believe, still well supplied with reserved forest. On the mainland I hear from the Venezuelan botanist, Dr. Tobias Lasser, of his efforts to conserve the forest. I mention these few cases to plead that here in England we should have a body that could support and encourage those who are willing to struggle in this very difficult task. I often wonder whether it is not greater to have saved some tropical forest from destruction than to have discovered a new genus, but the honours are the other way. When I was at Manaus, Adolfe Ducke and I persuaded the Governor of the State of Amazonas to reserve a large area of forest about ten miles from the city. We have both departed and I regret deeply

that the Governor has died. The forest, for want of any local support, has been entirely cut down and destroyed for charcoal. This would have been the situation in Singapore twenty years ago, but for the intervention of the staff of the Botanic Gardens, and it will be the general effect until an educated public arises to appreciate its own countryside. There are two ways in which we can help. One is by means of the introductory works, which I have mentioned, to put biology, natural history and scenery into education. The other is for those of us who are really concerned with tropical botany to find a means of urging on governments from without the desirability of ensuring nature reserves.

Lastly, I will mention the felling of the forest. As medicine has learnt so much from the battlefield, so can botany from the chaos of felling. The early collectors made great use of these opportunities, as one can tell from the richness of their collections in trees and lianes. In contrast, the modern expedition to some far distant place misses generally all the character of the forest. Yet this forest is practically inexhaustible : I am not sure if its specific content has ever been found to repeat itself. I often think that it would be far more profitable for the modern expedition to go where lowland and montane forest is being destroyed : it should not be difficult to find out such information through the forestry departments and, thus, to make use of these unique opportunities.

So, my approach to tropical taxonomy is this. Explain to the student that it is the basis of botany. Encourage and respect the rare worker in the tropics, however much he may be handicapped. Realize that the introductory books may reach further than the scientific monographs. Subscribe to the preservation of tropical forest, as the mainstay of future botany. And, when expeditions are no longer possible, turn to the task of the tropical flora and the world-monograph.

WHAT LAMARCK REALLY SAID

By H. Graham Cannon, F.R.S.
Beyer Professor of Zoology, University of Manchester.

" Great is the power of steady misrepresentation."—Darwin, 1876.

In the course of writing " An Essay on Evolution and Modern Genetics " (Cannon, 1956) it became evident to me that the views of Lamarck had been so distorted in the century-and-a-half since their first publication that an investigation into the matter might yield illuminating results. The following paper is the result of such a study and the quotation I have placed at its head speaks for itself!

The publication in 1859 of the *Origin of Species* produced a greater effect on biological thought than that of any other book before or since. It was probably the simplicity of the idea and the utter obviousness of the power of natural selection that caught the Victorian mind. Biologists almost without exception became, to say the least of it, evolution-minded and towards the close of the century, certainly in this country and on the Continent, Darwinism was triumphant. But the publication by Lamarck of his views on evolution, just fifty years before Darwin had no such spectacular result. The intellectual world was not ready for them. They were just as simple and were, in fact, more in harmony with current theological ideas than what many Victorians, erroneously, took to be the gross materialism of Darwin's views. They were never seriously dealt with by biologists and in fact, as Haeckel says, " were not understood by most men, and for fifty years were not spoken of at all " (quoted from Butler, 1879, p. 217). As Martin complained in 1873 in his introduction to a new edition

of Lamarck's *Philosophie Zoologique*, Lamarck's theory " had never even had the honour of being discussed seriously " (p. vi). Writing however in October 1901 the distinguished American entomologist Packard (1901, p. 424) after quoting from " upwards of forty working biologists, many of whom were brought up, so to speak, in the Darwinian faith " showed that " the pendulum of evolutionary thought " was " swinging away from the narrow and restricted conception of natural selection pure and simple, as the sole or most important factor, and returning in the direction of Lamarckism ".

This movement, which, from a study of the list of authors quoted by Packard, was most marked in America, was not however destined to proceed very far. It was simply swamped out of existence by the re-discovery in the opening years of the present century of Mendel's Law of Inheritance. Here was something which was no mere hypothesis but something which could be tested and re-tested by experiment—and it was an age of experiment—and the more it was tested the more infallible it seemed. It swept the field of biology and became, some will say appropriately, the dominant field of biological research. By the outbreak of the First World War, schools of Mendelian research had sprung up all over the scientific world. Then the brilliant successes of the application of Mendelian principles to the service of man during the War established Mendelism as something real and something proven. If the agriculturists through their knowledge of the Mendelian law could produce the types of cereals that they wanted surely it seemed that this must have been the same mechanism by which, in nature, the different species were evolved.

In all this scientific furore it is not surprising that both Darwinism and Lamarckism were forced to take a back seat. They became very recessive and to some appeared to have almost a lethal effect on biological thought. But they were not dead and their subsequent history is very illuminating.

To consider Darwinism first, the trouble here was that it did not stand up to experiment. Darwinism relies on the heritability of small fluctuating variations. In fact it stands or falls on the reality of this heritability. Clearly it is of no use Nature selecting a small but particularly valuable variation if that small character is not to be inherited. But all statistical analysis at that time failed to show that fluctuating variations of animals or plants were heritable and, as MacBride (1934, p. 111) pointed out years later, if this is so then " the bottom has dropped out of Darwin's whole argument of evolution ". And so for the time being Darwinism was dropped.

In the meantime, especially during the first three decades of the century the brilliant researches of the Mendelians established their law of inheritance more and more. The whole chromosomal basis of Mendelian heredity and the concept of the " gene " became incontrovertibly established. But at the same time it became evident that, Mendelism relying as it did in those days on a study of the inheritance of mutations as opposed to small fluctuating variations, it was doubtful whether the Mendelian Law of Inheritance was adequate to deal with the process of the origin of species. This however has proved no stumbling block for the neo-Mendelians.

Their attitude was summarized in a broadcast to the nation made by Waddington (1952) a few years ago. What he stated was this—that in those cases where it is not possible to identify separate Mendelian genes as being responsible for the appearance of any character, such as, for example Darwin's fluctuating variations, " the situation can be understood if we suppose we are dealing with many genes, each with too small an effect to be distinctly recognized " (Waddington, 1952, p. 759). In other words an experimental proof of the inheritance of fluctuating variations is no longer considered necessary! On the contrary since fluctuating variations are characters of an organism and since *ex hypothesi* the characters " which an animal inherits are controlled by a series of separate

hereditary units, commonly known as genes" (Waddington, loc. cit.), these variations *must* be represented by a gene complex. This having been assumed, all that is necessary is to "apply the same evolutionary argument" (Waddington, loc. cit.), in other words, let natural selection do its work and the problem is solved. Darwinism has thus come into its own again and the title of Waddington's broadcast which was put in the form of a question "Is the Problem of Evolution Solved?" should surely have been put as a positive statement "The Problem of Evolution *is* Solved"!

So much for the revival of Darwinism but the fate of Lamarckism is far otherwise. What Samuel Butler said in 1879 (p. 54)—"Lamarck has been so systematically laughed at that it amounts to little less than philosophical suicide for anyone to stand up on his behalf"—this applies *a fortiori* to-day. Lamarckism is in eclipse and it was largely the craze for experimenting—or rather the craze for refusing to accept as "proved" anything which could not be so demonstrated by experiment—that led to the present state of affairs. Experiments to demonstrate the validity or otherwise of Lamarckian inheritance have been attempted for years from Weismann to MacBride but in the majority of cases it must be admitted that it looks as though the experiments were carried out with a preconceived idea as to the results to be obtained and for this reason alone they have been viewed askance.

The experiments are all of the same pattern. The plan has always been to transfer an animal from its normal environment to a new one to see whether as a result of the new strange stimuli from the new strange environment a corresponding change in an existing organ or habit develops. If this happens in such a way that it may be seen or measured then the experiment may proceed. After the firm establishment of this "acquired character" the animal is transferred back to its original environment and breeding continued to see whether the induced character persists in subsequent generations. If it does, then say the experimenters, acquired characters are being inherited and Lamarckism is upheld. "But surely, all that such an experiment, if successful, would show would be that the environment had little effect on the characters of the animal. For if a new environment induced a new character, how much more so would the old environment wipe out that character when the experimental animal was transferred back to the original environment" (Cannon 1954, p. 232). As MacBride said (1916 p. 14) "if a change from one environment to another causes a change in structure in one generation, a change in the opposite direction should be sufficient to reverse it in an equal amount of time". The whole experimental technique was thus unsound and the experiments doomed to failure from the beginning.

But this was not all. It unfortunately has to be admitted that certain "Lamarckian" experiments were carried out with what purported to be success which were subsequently found to be—to put it mildly—unreliable. And it was this more than anything else that brought Lamarckism and anything connected with it into disrepute. Such an attitude is, of course, scientifically indefensible and hence the expression used by Darlington (1950, p. xvii) in the preface which he saw fit to write to the reprint of the first edition of the *Origin of Species*, in which he refers to "the discarded and disreputable theory of Lamarck", is utterly inexcusable. Discarded—yes, by most biologists, but why disreputable? One might just as well say that the study of fossil man is disreputable because of the existence of Eoanthropus!

The further remarks that Darlington makes in this preface illustrate well the prevalent ignorance of what actually constitutes Lamarckism. He states (*ibid.*, p. xv) that Darwin rejected Lamarckian evolution, which he refers to as that "ancient superstitution of the inheritance of acquired characters". Now in interpreting Lamarckism completely in this way he is simply wrong but

before discussing this point, since Darlington is so dogmatic in his condemnation of Lamarck, I feel I am entitled to point out that his statement suggests that not only had he not read his Lamarck but it is doubtful whether he had read his Darwin ! For in the *first* edition of the *Origin* (Darwin, C., 1859, p. 9) there occurs the passage where Darwin points out that the leg bones of the domestic duck are proportionately more massive and the wing bones less so than in the wild form and says that this " may be safely attributed to the domestic duck flying much less, and walking more, than its wild parent ". There can be no case here of natural selection picking out chance variations because in the barnyard natural selection is not at work. It is human selection and surely domestic ducks are not selected by breeders because of the size of their legs ! This passage indicates clearly that when Darwin first published his hypothesis he definitely believed in the inherited effects of use and disuse and in this sense was a Lamarckian. In fact as Jeffries states (1890, p. 45) " . . . as with most of Lamarck's laws, Darwin has taken them to himself wherever natural selection, sexual selection, and the like have fallen to the ground ".

To return to Darlington's definition of Lamarckism. In it he uses the term " acquired character " and since it is used without qualification it is to be presumed that he is using it in its biological technical sense. Now this has been very carefully defined by that great and very cautious biologist Leonard Doncaster. In his little manual on *Heredity* (1912, pp. 19–20) he points out that an acquired character means a changed character that is produced in an existing organ or habit by a change in the environment. It does not in any way include *new* characters. Now Lamarck enunciated his views ultimately in four laws and only the third and fourth of these deal with acquired characters in this modern technical sense. And these two laws, as I have shown elsewhere (Cannon, 1956) should be considered as subsidiary to his famous second law which deals with the origin of new characters. Thus to refer to the inheritance of acquired characters and Lamarckism as synonymous is to deprive Lamarck of what he considered his greatest contribution to evolutionary thought. But Darlington is in good company in his mistake. Poulton made the same mistake in 1909 and in fact as far as I can ascertain practically all references to Lamarckism in this century even by such authorities as Doncaster and of course MacBride are made in the incorrect restricted sense. That this is the generally accepted idea of Lamarckism I think follows from the fact that it is so frequently referred to as a belief in the inherited effects of use and disuse (Poulton, 1909, p. 33). Stated thus this clearly cuts out Lamarck's final second law as use and disuse can only refer to existing organs. Poulton (*ibid.*, p. 34) makes his attitude even more clear as he refers to " the Lamarckian theory of hereditary experience ".

The origin of this mistake can probably be traced back, at least partly, to the unfortunate way in which Lamarck published his views. There are references to the evolution of organisms in all his writings from 1801 onwards. But he enunciated his evolutionary laws in two separate major works separated by an interval of six years. In 1809 he published his famous *Philosophie Zoologique* and in 1815 he commenced publication of his *Histoire Naturelle des Animaux sans Vertèbres*. In the first of these he enunciated two laws (Lamarck, 1809, pp. 235–236) labelled the first and second and these two laws represent the modern generally-accepted view of Lamarckism namely, a belief in the inherited effects of use and disuse. The relevant parts of these laws may be translated as follows :—

First Law.

In every animal . . . the more frequent and sustained use of any organ little by little strengthens this organ, develops it, and enlarges it and gives it a strength proportional to the length of time of such use ; on the other hand,

the constant lack of use of such an organ, imperceptibly weakens it, causes it to deteriorate, progressively diminishes its faculties and ends by causing it to disappear.

Second Law.

Everything that nature has caused individuals to acquire or lose by the influence of circumstances to which their race may be for a long time exposed, and consequently, by the predominant use of some organ or by that of the continued lack of use of such part ; it preserves by heredity in those new forms which arise from such individuals . . .

Later however in 1815, in the introduction to the first volume of his *Invertebrate Zoology* he again stated his evolutionary views but this time as four laws (pp. 152, *et seq.*) of which his previously-published laws which I have just quoted became his third and fourth laws.

These can be briefly stated as follows :—

First Law.

Life, by its own force, tends continually to increase the volume of every living body and to extend the dimensions of its parts, up to a limit which it imposes.

Second Law.

The production of a new organ in an animal body results from a new need (besoin) which continues to make itself felt, and from a new movement that this need brings about and maintains.

Third Law.

The development and effectiveness of organs are proportional to the use of those organs.

Fourth Law.

Everything acquired or changed during an individual's lifetime is preserved by heredity (generation) and transmitted to that individual's progeny.

In the circumstances it is not surprising that there is some ambiguity as to what actually represents Lamarckism, that is, Lamarckism in its entirety. On the other hand it is difficult to see how such an eminent zoologist as Poulton, writing as he did in 1909 for the jubilee celebrations of the publication of the *Origin*, when an accurate comparison of Darwin's efforts with those of other evolutionists was so important, should have failed to see that Lamarck went much further than the original two laws in his *Philosophie Zoologique*, failed in fact to see that in 1809 when he published them he firmly believed in his ultimate second law—the central part of his whole hypothesis—the law which states that the *need* of a new organ leads to its appearance. For Lamarck, in 1809 after quoting his two laws (p. 236) states in the next-but-one paragraph—only six lines further on—that naturalists have believed that the possession of certain organs has led to their employment. But he says this is wrong for it is easy to demonstrate that it is to the contrary " the needs and uses of organs which have developed these same parts, *which have even given origin to them where they did not exist*". This is something much more than the inherited effects of use and disuse. Is it possible that Poulton never read these passages? A page further on Lamarck quotes a passage from a work which he published in 1802 (p. 50) entitled *Researches on Living Bodies* in which this fundamental idea is clearly indicated. This reads as follows :—" It is not the organs . . .

of an animal which have given rise to its habits and its particular abilities ; but it is, on the contrary, its habits, its manner of life . . . which have, with time, brought about the form of its body, the number and condition of its organs and finally, the abilities that it possesses ". The inclusion of the words " the number . . . of its organs " clearly indicates that even as early as 1802 Lamarck believed in the origination of new organs in relation to new requirements. But later (Lamarck, 1809, p. 258) he is even more precise. He states " I shall show . . . that when the will urges an animal to any particular action, the organs which should carry out this are immediately stimulated (provoqués) . . . It results that the . . . repetition of these acts of organization strengthen, extend, develop, *and even create the organs which are necessary* ".

There is in fact no difference of any substance between the views expressed in his *Philosophie Zoologique* and in his later book. In the latter there are the extra two laws which leave no doubt as to the scope of his hypothesis. But the text adds little if anything to the expression of his views in his *Philosophie Zoologique*. Perhaps one quotation may be of value here. He states that animals experience needs and these needs require a response at some particular part of the body. "Now, if there exists at this point an appropriate organ, it is soon stimulated to action ; if such an organ does not exist, and the need is pressing and sustained, *gradually the organ will be produced* and will develop in proportion to the continuity and energy of its use " (Lamarck, 1815, pp. 152 *et seq.*)

Now this misinterpretation—this belittling—of Lamarck's hypothesis which we in this mid-twentieth century have inherited is, as I shall try to show, of vital importance in evaluating Lamarckism in what is called " modern genetical theory ", but it has not always been with us, for those eminent Victorians who deigned to consider Lamarck's views did not make it. They made other mistakes equally or even more damaging to Lamarck. And, strange as it may seem, these mistakes appear to have arisen at first simply through the inability correctly to translate Lamarck's writings and then later in the century without doubt through repeating what had previously been stated without verifying the statements from the original sources.

The first misrepresentation arose from an account of Lamarckian principles given by Lyell in his *Principles of Geology*. This has been referred to by Packard (1901, p. 71) as " the best, most catholic, and just exposition of Lamarck's views . . . and . . . still worth reading ". It certainly is an admirable concise account of Lamarck's views but Lyell breaks off in the middle of it (Lyell, 1834, **2**, p. 332) to make some most stringent criticisms accusing Lamarck of " disregard to the strict rules of induction . . . and . . . resorts to fictions, as ideal as the ' plastic virtue ' and other phantoms, of the geologists of the middle ages " ! His criticism is this—according to him Lamarck said that " organs no longer in use are impoverished and diminished in size . . . are sometimes entirely annihilated, while in their place new parts are insensibly produced for the discharge of new functions " (Lyell, loc. cit). He complains that " no positive fact is cited to exemplify the substitution of some *entirely new* (the italics are his !) sense, faculty or organ in the room of some other suppressed as useless " (Lyell, loc. cit.). But Lamarck did not say this. On the page quoted by Lyell (Lamarck, 1809, **1**, p. 234) is the statement " that every new need necessitating new action to satisfy it, demands of the animal that experiences it, *either* (soit) the more frequent use of such parts as had been less used before, which develops and considerably enlarges them, *or* (soit) the use of new parts which the needs have caused insensibly to arise in it . . . " (the animal concerned). Nowhere is there any suggestion that " entirely new " organs arise *to take the place of organs* vestigial to extinction. How it came about that Lyell was unable to translate this simple and very clear statement

is a mystery*. However he only makes this one criticism and the remainder of the passage (Lyell, 1834, pp. 326–339) is a straightforward account of Lamarck's views, containing here and there a comment but no other criticism. Elsewhere throughout the book there are three or four passages where Lyell begs to differ from Lamarck on more or less minor points—but there is no prolonged attack on his views generally. And this is not surprising in that in 1827, only three years before the first edition of Lyell's *Principles*, in a letter to Mantell he expresses his delight at Lamarck's theories (quoted in F. Darwin, 1887, **2**, p. 191).

It is possible in view of what I have just said that Lyell's misguided criticism might soon have been forgotten. But this was not to be for it was revived in an equally misguided manner by T. H. Huxley (1887) in his article "On the Reception of the *Origin of Species*". Here after making most disparaging remarks about what he imagined Lamarck to have said in his *Philosophie Zoologique* he states that at the time of writing half of what Lamarck said was "obsolete and the other half erroneous, or defective . . ." (*ibid.*, p. 189) and then goes on to refer to "Lyell's *trenchant and effectual criticism*"! He states that some thirty-five years previously he had "studied Lamarck attentively" (*ibid.*, p. 188) and presumably he had read his Lyell but how did he come to overlook Lyell's mistake? It would certainly appear as though he had relied on memory and not attempted to check Lyell's statement for the fault that he himself quotes in this passage as condemning Lamarckism is that it postulates only "one suggestion as to the cause of the gradual modification of species—effort excited by changed conditions . . .". Apparently he was under the impression that it was from this point of view that Lyell had criticized Lamarck but this is not so. Lyell did not mention it—but it is the point made by all the other critics of that time and, as in the case of Lyell, it is due to a mistranslation or at least a misinterpretation.

It arose simply through the inability to translate accurately the word "besoin". Lamarck stated that it was "les besoins"—the wants—of an animal that lead to the evolution of the appropriate organ to satisfy that want. And this, with a puerility that it is difficult to conceive, was distorted by those who wished to condemn Lamarck into the statement that if an animal wanted an organ then it appeared! That is, the word "want" was used in the human sense as involving an act of will—as synonymous with desire! Needless to say, as Packard pointed out (1901, p. 324) "This . . . elicited so much adverse criticism and ridicule, and . . . in many cases led to the wholesale rejection of all Lamarck's views".

There is absolutely no excuse for the mistake. Lamarck makes it abundantly clear by continually referring to the "*inner* feeling" of animals that he had a very shrewd idea of what we should nowadays call the subconscious activity of organisms. He states (1809, **2**, p. 286) "The inner feeling takes the place, of the *will*; for it is now important to consider that every animal which does not possess the special organ, in which or by means of which it executes thoughts, judgments, etc. has in reality no will, does not make a choice, and consequently cannot control the movements which its inner feelings excite". Could anything be plainer than this?

In the light of the rudimentary state of knowledge of functional anatomy of his day, Lamarck divided the animals into those with a brain by which he apparently meant only the "higher vertebrates" (Packard, 1901, p. 331) and those which are only "sensible" (Lamarck, 1809, p. 292) which are without a brain and so "cannot think, reason or perform intelligent acts". In this group he placed all the known invertebrates and the lower vertebrates, the fishes and reptiles (presumably including the amphibia). It is interesting that

* Strange to say even Packard does not render the passage correctly for he translates "soit . . . soit" as "both . . . and" (Packard, 1901, p. 302).

Packard writing at the opening of this century comments that it is a strange view to take that an insect has no brain and on purely anatomical grounds this would be a just criticism. But in the light of our present-day knowledge of the functional anatomy of the central nervous system it is clear that Lamarck was in a large sense correct. He realized that the behaviour of an insect was simply one mass of reflex activities—a behaviour devoid of any intelligence. And how up-to-date he was in his evaluation of instinctive behaviour is shown by the statement he makes that it is always correct. Referring to instinctive acts he states (1809, p. 296) that " as these acts are never the result of deliberations, of choice or of any sort of judgment, the actions which arise from them always satisfy, *surely and without error*, the wants felt . . . arising from habits ". To Lamarck the activity of an animal, its behaviour, was intimately bound to its environment and as this environment remained from generation to generation largely the same so the behaviour became stereotyped. Its life became, as Wood Jones so aptly said, " the performance of appropriate actions begot in response to biologically relevant stimuli " (Wood Jones & Porteous, 1929, p. 56). But Lamarck saw further than this. He had a very definite idea of the struggle for existence and of the power of natural selection (Lamarck, 1809, p. 131) and it can be safely deduced from his writings that he saw that if an animal did *not* respond in the most appropriate manner to change in its environment it would clearly be eliminated. And that is why he said that the animal instinctively reacts always " surely and without error ". He anticipated Wood Jones' aphorism (*ibid.*, p. 57) that in instinctive behaviour " the usual produces its wanted response ".

As regards the higher vertebrates—the birds and mammals which Lamarck said possessed a brain, an organ sufficient for intelligent behaviour—they " nevertheless make the greater part of their actions by instinct and habit, and in this respect, they never make mistakes " (Lamarck, 1809, p. 312). But then he continues that when such an animal acts according to its will " that is to say as a result of a judgment, it still does not make a mistake or at least very rarely, because the elements which enter into such judgment are very few in number, ' et qu'en général, ils leur sont fournis par les sensations ' ". By this last phrase I take him to mean that such elements arise simply through stimulation of the various sense organs. And since among animals " of the same race (it must be remembered that he is referring to wild animals only) there is no inequality in intelligence and in the ideas of the individual ", they respond almost exactly in the same manner to the same circumstances.

All this was written nearly a century and a half ago and it is amazing to see how Lamarck has anticipated so many of our modern ideas of animal behaviour. Not only did he fully realize that such animals as barnacles and molluscs, insects and spiders are purely creatures of instinct but he foresaw that those higher vertebrates in which—as our modern anatomical studies can demonstrate—there is no doubt a glimmering of intelligence, still have a very circumscribed background to their voluntary actions, and as a result tend to act in the same way in the same circumstances. In view of this—of the obviously profound knowledge of behaviour that he showed in his writings—far in advance of his day—it is little short of incredible to see how his views were distorted in the later Victorian days.

To return to the inexcusable mistranslation of the word " besoin ". To say that I want (désire) something is obviously different from saying that I experience a want (un besoin). I may want a drink but if I say so I must have thought about the matter and hence this statement is the result of an act of will (volonté). But having had my drink, I experience the want (besoin) of digesting it properly. This is something beyond my control. In the normal course of events it will be digested properly whatever I may think about the

subject—that is however much I may use my will. Now Lamarck clearly used the word " besoin " in the sense of an animal experiencing a want—that is in the purely subconscious manner and something quite apart from intelligen thinking, and it is in the other manner, as something involving the will, that those detractors of Lamarck have erroneously stated that he used the word.

Rostand (1947, p. 76) after pointing out that Lamarck in his theory " did not rely on the intervention of the will of animals " states that Darwin when he speaks of the Lamarckian theory always makes this mistake. I cannot find that this is so. In fact the difficulty is to find references to Lamarck in Darwin's books. Darwin was not the culprit but his co-author of the idea of natural selection, A. M. Wallace, certainly was at fault. As Packard points out (1901, p. 351) Wallace was wrong in quoting Lamarck as having said that an animal acquires a structure by " desiring " to do so and so. To desire is to want actively and it is something, as I have just pointed out, quite different from " to experience a want ". However Wallace's mistake is as nothing to that of T. H. Huxley.

Now what Huxley said was of tremendous importance, far more so than Wallace's activities. After all Darwin left it to others to fight the battle of evolution. He did not give lectures or attend scientific meetings. It was Huxley who did all the talking for him. In fact as MacBride (1934, p. 59) pointed out, what gave Huxley " his world wide fame was the propaganda which he conducted in favour of Darwin's theory of evolution . . . ". So that it is certain that anything said by Huxley on the subject of evolution at a lecture or published in an article soon became common knowledge to the whole biological world. Now I have already pointed out the mistake Huxley made by quoting Lyell without checking his references. In that same passage (Darwin, F., 1887, **2**, p. 189) he makes a very disparaging remark about Lamarck by referring to him as " *buccinator tantum* "—merely a trumpeter—an expression used when one wishes to indicate that someone is only reproducing someone else's music and not doing anything original, and there is a footnote to explain this allusion. Apparently Huxley considered that Lamarck merely plagiarized Erasmus Darwin. However, whether this be so or not, if anybody acted as " buccinator " in those days surely it was Huxley, at least as regards evolution, and in blowing the trumpet of Lamarck it is a great pity that he did not stick more accurately to the score !

In 1863, that is four years after the first appearance of the *Origin*, when interest in the subject of evolution was rising to its maximum, Huxley gave a course of " Six Lectures to Working Men " (Huxley, 1863). It is in the last of these that he attacks Lamarckism. He starts by making the usual mistake (p. 149) for he quotes Lamarck as having said that " an animal may be modified . . . in consequence of its *desires* and consequent actions ". But then he continues, " Lamarck . . . said, for example, that the short-legged birds which live on fish, had been converted into the long-legged waders *by desiring to get the fish without wetting their feet*, and so stretching their legs more and more through successive generations ". A more ridiculous statement it is difficult to imagine because, of course, however long the birds' legs might be, if they had to go to the water to catch their fish, they would get their feet wet ! What Lamarck actually said (1809, **1**, p. 249) was that such birds would " put all their efforts into extending and elongating their legs " in order to prevent the *body* from plunging into the water—a statement which, whether one accepts Lamarck's views or not—is perfectly rational. In the next paragraph he refers to the bird wishing to fish without getting its body wet, and it is presumably this statement, which as a matter of fact does not refer to the long legs at all, but to the long *neck*, that Huxley has so distorted. One has only to think of such a bird as a heron standing motionless with its long legs in the

water at the edge of a loch to understand Lamarck's point. Of course if such a bird waded in so that its body " plunged into the water " naturally any fish nearby would be scared away. Whether Huxley got his information from some ignorant person or whether he omitted to check his reference is beside the point. To attribute to any scientist whose views are under discussion a statement which is patently absurd is inexcusable. His mistake was soon pointed out to him, but by this time the harm was done. In a letter to Huxley from Charles Darwin dated 7 December 1862, there was found a slip of paper written some time in 1863 apparently by a Miss Henrietta Darwin which merely asks laconically " wetting *feet* (her italics) or bodies ? ". Francis Darwin & Prof. Seward (1903, p. 216) place this on record and do so without comment and so it can only be presumed that they too did not think it worth while to refer to the original source to check such a fantastic statement !

And now after completely distorting Lamarck's statement, look at the partisan way Huxley treats Lamarck's views in comparing them with those of Darwin. He states (*ibid.*, p. 150) that Lamarck was unable to show *experimentally* that " even races of animals " could be produced in the way he suggested and for this reason " his hypothesis has pretty well dropped into oblivion, *as it deserved to* " ! Now see what he says about Darwin. A few pages previously (*ibid.*, p. 146) he points out that if Darwin's views are correct he ought to be able to develop experimentally " from a particular stock by selective breeding, two forms . . . " which should be sterile *inter se* but he adds, " it has not been found possible to produce this . . . " and therefore one can only deduce that Darwin's views also deserved to be dropped into oblivion ! But far from it—in these lectures he was out to show that it was " either Mr. Darwin's hypothesis or nothing " (*ibid.*, p. 150)—all other views, but particularly those of Lamarck, were apparently to be treated with contumely. Charles Darwin said " Great is the power of steady misrepresentation " (Darwin, 1878, p. 421) but it seems, at least as regards Lamarckism, that he was over sanguine when he added the words " but the history of science shows that fortunately this power does not long endure ".

And now as regards the attitude of Charles Darwin himself to Lamarckism. This is a complete puzzle. When he does refer to Lamarck, certainly in his later books he is fair in his statements and obviously appreciates Lamarck's position in the biological world. Thus in the historical sketch which acts as preface to the 6th edition of the *Origin* (1878, p. xiii) he refers to " this justly-celebrated naturalist ". In the *Origin* itself there is only one reference (1859, p. 362) which persists through subsequent editions where Darwin points out that Lamarck was the first to call attention to the differences between, as we should say nowadays, homologous and analogous organs. But there are no references to Lamarck's general evolutionary views. In twelve of Darwin's major works apart from the *Origin* and selected at random I was able to find only one reference to Lamarck—and that was trivial—in their indexes. On the other hand, in his letters, he is most outspoken, confining himself to generalizations but condemning Lamarck outright. When he does deal with specific points he misinterprets Lamarck or is at least inaccurate*. Thus he makes the usual mistake of accusing Lamarck of attributing will power to animals in the process of evolution (Rostand, p. 76). Writing to Hooker in 1844 (Darwin, F., 1887, **2**, p. 23) he calls on Heaven to protect him from such " Lamarck nonsense " as " adaptations from the slow willing of animals " and in a later letter to the same man (*ibid.*, p. 29) in which the nonsense has

* In his letter to Huxley (Darwin, F. & Seward, 1903, letter 76, p. 125) where he insinuates that Lamarck's views are to be found in Erasmus Darwin's *Zoonomia*, he refers to Lamarck's *Hist. Zoolog.* published in 1809. There is no such book—a fact apparently overlooked by the editors !

now become " veritable rubbish " he says that it is strange that such a man as Lamarck, for whom apparently he had great admiration as the author of his text-book on Invertebrates, should " have written that insects, which never see their eggs, should "*will* . . . to be of particular forms ". Why insects never see their eggs, or in any case, why such a fact could be of any importance is not clear ! Apart from this he gives Lamarck no credit for any views which appeared in the various editions of the *Origin*. Thus writing to Lyell in 1859 just before the publication of the *Origin*, when in fact he was still handling the proof sheets, he added a postscript complaining that Lyell so often alluded to Lamarck's works. In his opinion, he states, the work appeared extremely poor and he " got not a fact or idea from it " (Darwin, F., **2**, p. 215). Then some four years later writing to the same correspondent, he " gained nothing " as he well remembered to his surprise from reading Lamarck's wretched book " (Darwin, F., **3**, p. 14). Which book he refers to he does not say*, but it has always been assumed that it is Lamarck's *Philosophie Zoologique*. Why this assumption has been made I do not know for it might equally well have been his *Histoire Naturelle des Animaux sans Vertèbres*. It should be remembered that some years before the *Origin* appeared Darwin had established himself as a very great comparative anatomist. He had produced his two Ray Society Monographs on the Cirripedia (1851–54)— a work which still remains in many respects an authoritative masterpiece. And in this work he surely must have referred to Lamarck's Invertebrate text-book where, as I have fully explained, he could have found Lamarck's evolutionary ideas set out in their most complete and concise form.

However, whichever book it is that Darwin referred to he says that he did not acquire any new views from its reading, and Rostand (1947, p. 142) points out " If Darwin says that he got nothing from the works of Lamarck— we must believe him ". But that is just where the puzzle arises. In the first edition of the *Origin* as I have already pointed out (p. 73) Darwin shows himself a firm believer in Lamarck's third and fourth laws— that is a believer in the inherited effects of use and disuse, and, as I shall show presently, in later editions he became more definite on this point.

Now in 1842 as he states in his autobiography, Darwin wrote a short abstract of his theory— an essay of thirty-five pages. In the first paragraph of this work he points out that an organism placed in a new environment sometimes varies in a variety of ways, among others, in its habits. " Also habits of life develop certain parts. Disuse atrophies ". (Darwin, F., 1909, p. 1). Thus at that early date he believed in Lamarck's third law. In the original manuscript he wrote after the words just quoted " Most of these slight variations tend to become hereditary " and then he crossed this out. He was thus not yet ready to accept Lamarck's fourth law. However a dozen or so pages later (Darwin, F., p. 18) he wrote " It must I think be admitted that habits whether congenital or acquired . . . " then he wrote " sometimes " and crossed this out and ended up with " often become inherited ". From this it can only be deduced that he had succumbed to Lamarck's fourth law†.

In both these passages it will be noted that he did not mention Lamarck so that it would have been possible that at this date he had not read any of his works but had independently thought out his " Lamarckian " views. However there is a reference in between (*ibid.*, p. 10) which shows that this is not so but at the same time serves only to confuse the issue. In a paragraph dealing with

* A bibliography of the writings of Lamarck occupies 18 pages of small print ! (Packard, 1901, pp. 425–443.)

† Francis Darwin softens the blow by pointing out in a footnote that at that time (1842) " and for long afterwards the inheritance of acquired characters was assumed to occur ".

selection he ends up, without any apparent reference to what he has just written, with the sentence " Introduce here contrast with Lamarck—absurdity of habit or chance ?? or external conditions, making a woodpecker adapted to tree ". He seems to be condemning not only Lamarck's views but his own reliance on fortuitous selection of variations which looms so large in his hypothesis.

However whatever views Darwin held before 1859 there is no doubt that as edition after edition of the *Origin* appeared he became a definite believer in what is generally accepted as Lamarckism. For in the sixth edition there appears a new chapter inserted between the original chapters six and seven, and in this—referring to the evolution of the giraffe—he explains (C. Darwin, 1878, p. 178) how according to his own theory this could have been brought about and then adds the words " combined no doubt in a most important manner with the inherited effects of the increased used of parts ". He thus not only came to believe in what is nowadays considered to represent Lamarckism but attributed to it an important part in the process of evolution.

But now just to make matters worse, in the historical sketch which appears in the later editions of the *Origin*, (Darwin, C., 1878, p. xiv, footnote) he definitely implies that Lamarck plagiarized his grandfather Erasmus Darwin. In this he is quite erroneous for the latter said that an organ must have preceded the power to use it (E. Darwin, 1794, 1, p. 497) which is the direct opposite of Lamarck's second law (see p. 74). But whatever view he took of Lamarck's hypothesis, surely he himself is plagiarizing Lamarck—and therefore I suppose, according to his views, his own grandfather—for where he relies on the inherited effects of use or disuse he makes no acknowledgement to either of them.

There lies the puzzle. On Darwin's own words there is no doubt that he studied at least one book of Lamarck's which contained evolutionary ideas. He treats it with scorn and contempt and then says he got no new ideas from it, and yet there, in his own writings, is plain straightforward " Lamarckism " without any acknowledgment. Whether this ignoring of Lamarck was deliberate it is impossible to say, but it must be admitted that it is difficult to see any other probable solution. Darwin was always liberal in his references and yet nowhere is there a reference to his indebtedness to Lamarck. It is not surprising that this treatment combined with the evangelistic propaganda of Huxley, about which I have said quite enough, was sufficient to banish Lamarckism, at least in this country, almost into oblivion.

Now I have just referred to the evolution of the giraffe and I am going to deal in detail with Lamarck's views on this matter, first, because these have been persistently misrepresented by some of our greatest biologists even up to the present day and, secondly, because in fact, they demonstrate so clearly the essence of real Lamarckism and its differences from other hypotheses.

What Lamarck actually said was this (1809, **1**, p. 255), referring to the peculiar form and to the stature of the giraffe, " one knows that this animal . . . lives in the interior of Africa and that it lives in those localities where the earth, being nearly always arid and without low growing vegetation (herbage), this forces it to browse on the leaves of trees and continually to strain itself to reach them. As a result of this long continued habit, in all the individuals of the race, the front legs become longer than the hinder, and the neck elongated to such an extent that the giraffe without raising itself on its hind legs can reach to the height of getting on for 20 feet ". Nothing could be simpler or more straightforward than this and yet Wallace (1858, p. 41) in his famous essay on *Natural Selection* distorts it completely by saying that according to Lamarck the giraffe acquired its long *neck* by desiring [*sic*] to browse on the higher trees. No mention is made of the forelegs and from that day to this, it has been the evolution of the *neck* of the giraffe which has been held up to

ridicule. Even such eminent and careful scientists as Doncaster (1912, p. 136) and Judd (1912, p. 88) make the mistake. And yet it was not the neck but the forelegs that Lamarck primarily referred to. He said that the animals continually strove or exerted themselves (s'efforcer) to reach the higher leaves on the trees and it is reasonable to interpret this to mean that the animals developed the habit of continually reaching upwards by pushing themselves up on their front legs and as a result these became elongated. Now this is a perfectly reasonable statement and whether one is a Lamarckian or not, it cannot be denied that the continual extra pressure put on the ends of the long bones of the forelegs by this habit *might* stimulate those bones to elongate. But now apply the same argument to the neck. It is said by Doncaster and others that, according to Lamarck, the animal strove to elongate its neck and so it elongated. But the fallacy is that neither a giraffe nor any other vertebrate can strive to stretch its neck. A neck can be stretched *out* but it cannot be actively *stretched*! The act of stretching out a neck might in fact by pressure on the intervertebral elements slightly diminish the total length of the neck but it cannot increase it. It is morphologically impossible. Let any of my readers try to will themselves to elongate their necks. It cannot be done simply because there is no muscular system by which such a process could be carried out and hence no corresponding nervous mechanism. It is in fact an absurdity and as such it has been treated by all modern writers*. But then Lamarck did *not* make such a suggestion. What he said was something much more profound. This can be better appreciated if we interpret his argument in the light of his four laws. The "nascent giraffe", to use Darwin's expression, uses its front legs continually in its striving to reach higher up the trees. Therefore according to Lamarck's third law these limbs become elongated and according to his fourth law such acquired extra length will be inherited. But now, however long the front legs become the animal still has to drink water and that water is on the ground. Clearly then if the front legs become longer a new need arises, a need of the whole organism —the need of a correspondingly long neck to enable the animal to drink and so, according to Lamarck's *second* law, it arises.

Now see what Darwin has to say on the same problem. He first of all says that the evolution of the giraffe is due in a large degree to the inherited effects of use. This is the passage (Darwin, 1878, pp. 177–178) where I have already pointed out Darwin definitely confesses himself a believer in "Lamarckism" without making any acknowledgment to its author. But for the rest he relies on natural selection picking out fortuitous variations for survival and producing this "beautifully adapted" form. Thus he says that "those individuals which had some one part or several parts of their bodies rather more elongated than usual, would generally have survived" (loc. cit). Compare this utterly diffuse statement which at least leaves a lot to the imagination with Lamarck's precision. In those words "one part *or* several parts" it is clear that Darwin had no real idea about correlation between parts. He did not see that it was of no use the front legs getting longer unless the neck elongated accordingly. His ideas of correlation as others have said were singularly incomplete. He refers (C. Darwin, 1878, p. 9) to the "mysterious laws of correlation" and even remarks (loc. cit.) that "some instances of correlation are quite whimsical"! He concerns himself with such trivialities as that white cats with blue eyes are generally deaf but overlooks the fundamental point that the variation of any

* At the meeting of the Society at which this paper was read it was suggested that the act of pulling down the highest branches that the animal could reach would in itself stretch the neck, just as a rope used to pull down a tree would become stretched by tension. This, of course, is not so. The affect of pulling on the neck of a living animal would be the reverse for it would immediately stimulate the muscles to *contract*, so that the neck insofar as the intervertebral ligaments would allow would actually contract to a minute extent. On the other hand the neck of a dead animal would naturally stretch in the same way as a rope.

one part *without* the related variation of other parts would always lead to a less efficient variety which would be, according to his own theory of natural selection, wiped out of existence. Organs or parts of the body, to use Darwin's words, are not isolated structures to vary fortuitously. To consider an organ apart from the rest of the living body is as illogical as to consider a living organism apart from its environment. An organism is in equilibrium with its surroundings—an organ is in equilibrium with the rest of the body—and, since it is impossible to alter one constituent of an equilibrium without altering in some way the other constituents it follows that no organ in a body can possibly alter without corresponding changes in its related parts. It is the organism as a whole which must vary and, if it is to avoid annihilation, it must and does vary in the right direction (Cannon, 1956). Waddington (1952) was driven to this conclusion although apparently he did not see it when, in his effort at translating Darwin's hypothesis into Neo Mendelian terms, he had to call on an " harmonious control " for assistance. But Darwin in his reliance on fortuitous fluctuating variations cuts right across this idea. To him there was no organismal control or directiveness in evolution (Wood Jones, 1953). As Butler (1879, p. 36) so succintly put it he considered evolution the result of " blind chance, working nowhither, and due but to the accumulation of innumerable lucky accidents ". To him the characters of an organism were treated like so many marbles in a box.

And now, in view of what I have just said, let us review Lamarck's hypothesis as he enunciated it in his four laws (see p. 74).

His first law about which I have said practically nothing beyond quoting it is ignored by everybody as far as I can make out and even by Lamarck is scarcely referred to. In fact it is difficult to see why he thought it necessary to enunciate it as a separate law. If I understand him rightly he argues that since an organ when it is used considerably tends to enlarge then as organisms are complexes of organs and those organs are continually being used it follows that the organisms themselves must tend continually to increase in size by their own activities. Whether or not he is right in his premiss is uncertain but nobody seems to have contradicted his statement. I am afraid too much reliance is placed on the case of the blacksmith's arm ! The biceps muscle and its associated muscles may become larger in an active blacksmith but surely this does not always happen. A nerve does not increase in size with continued use, nor does a blood vessel. A gland might but I don't think this has been established as a fact. Nevertheless I feel that Lamarck's first law, as a mere statement of fact, however unnecessary it may be to the rest of his thesis, is true. Moreover it is valuable in that if it is reversed it emphasizes the important point that in any evolutionary line the most primitive forms must always be relatively small. If Gaskell had known of Lamarck's first law he would never have attempted to derive vertebrates from *Limulus* ; and if the Victorians had realized its truth they might have been less ready to look for their " missing links " among large existing modern forms. However, whether true or not, it does not appear to have any influence on the other three laws, and so we can leave it.

Now as regards the second law which is the central part of his hypothesis, he states that if in the changing environment of an animal a new need arises which necessitates the appearance of a new organ, then that organ will be produced. But now a new organ cannot put in an appearance without being developed *to a particular degree.* It must be either small and simple or large and complex or something in-between. Lamarck actually says that the organ will be produced *in proportion as it is used* and in this statemen the is incorporating his third law.

Now his third law is the one which appears to be generally accepted by all. The development of an organ, which term includes not only its size but its

efficiency, is proportional to the use of that organ. In other words organs much used are either large or very efficient or both while those which are not used tend to disappear or at least to become inefficient. Thus the second and third laws as far as I can see are bound together and should be considered as one fundamental law.

We are left now with only the fourth law, the law which implies a belief in the inheritance of acquired characters. This is the law which, as I have pointed out, is so vigorously and scornfully denied by the great majority of biologists. And yet is it, after all, necessary? In view of what is stated in the second and third laws is it not redundant? According to the third law, during the life of an individual an organ and its related structures develops proportionately as it is used. According to the second law during the continuance of a race an organ and its related structures evolves proportionately as it is required. Very well then, does it matter whether or not the effects of use or disuse acquired during the lifetime of an individual are passed on *as such* to the next generation? They will appear in any case in the succeeding generations as if they had been so inherited but this will be by virtue of Lamarck's combined second and third laws. Thus the one part of Lamarck's hypothesis, the part which the modern biological world has labelled " Lamarckism " is the one part that can be safely discarded.

The importance of this in modern genetical theory is obvious. The great argument used by those who opposed the possibility of the inheritance of acquired characters was that they could see no means by which somatic changes could affect the constitution of the germ cells. If Lamarck's fourth law is abandoned then this difficulty goes with it.

We are then left with his central theme. It was the needs of an organism, he said, which changed with changing environments and resulted in its varying always in the appropriate manner. The organism evolved " as it were by sheer force of circumstances " (Bateson, 1894, p. 4). But that evolution was not brought about by the chance variations of independent parts or organs as Darwin would have us believe. It was through the co-ordinated changes in the various parts that progress was made. It was to him the organism as a whole that evolved. If one part of an organism changed then there was something inherent in that organism which ensured that all the other associated parts changed accordingly so as to perpetuate the efficiency of that organism. As Bateson (loc. cit.) puts it so precisely in his survey of Lamarck's views " there is in living things a certain *tension*, by which they respond to environmental pressure and fit the place they are in, somewhat as a fluid fits a vessel ".

And now to summarize this sorry story. There appear to have been three phases in the attitude of scientists to Lamarck's views corresponding to the three half-centuries that have elapsed since their first appearance. In the first half-century the only criticism of any importance came from Lyell and was based solely on a mistranslation of a simple passage. Apart from this, Lamarckism, in this country, received scant notice. In the next fifty years which is the period immediately after the publication of the *Origin* most vitriolic attacks were made on Lamarck again based on a mistranslation which attributed to him the view that if an animal desired [*sic*] an organ then that organ would appear. And finally during the last half century Lamarckism has been interpreted as including solely a belief in the inheritance of acquired characters and it is just this part of Lamarck's hypothesis—his fourth law—which is redundant and can be abandoned.

References.

Bateman, W. 1896. *Material for the Study of Variation.*
Butler, S. 1879. *Evolution, Old and New.* (Shrewsbury Ed. 1924.)

CANNON, H. GRAHAM. 1954. Is the problem of evolution solved ? *School Sci. Rev.* **126**.
——. 1956. An essay on evolution and modern genetics. *J. Linn. Soc.* (*Zool.*), **43**, p. 1.
DARLINGTON, C. D. 1950. Introduction to the first reprint of the 1st edition *On the Origin of Species by Means of Natural Selection*, by Charles Darwin.
DARWIN, C. 1859. *On the Origin of Species by Means of Natural Selection.*
——. 1878. *The Origin of Species.* Ed. 6 with additions and corrections to 1872.
DARWIN, F. 1887. *The Life and Letters of Charles Darwin including an Autobiographical Chapter.*
——. 1909. *The Foundation of the Origin of Species, a Sketch Written in* 1842 *by Charles Darwin.*
DARWIN, F. & SEWARD, A. C. 1903. *More Letters of Charles Darwin.*
DONCASTER, L. 1912. *Heredity in the Light of Recent Research.* (Ed. 2.)
HUXLEY, T. H. 1863. *On Our Knowledge of the Causes of the Phenomena of Organic Nature, being Six Lectures for Working Men.*
JEFFRIES, J. A. 1892. Lamarckianism and Darwinism. *Proc. Boston Soc. Nat. Hist.*, **25**, 42.
JUDD, J. W. 1912. *The Coming of Evolution.*
LAMARCK, J. P. B. A. 1802. *Recherches sur l'Organisation des Corps vivants.* Paris.
——. 1809. *Philosophie Zoologique.* New Ed. 1873.
——. 1815. *Histoire Naturelle des Animaux sans Vertèbres.*
LYELL, C. 1834. *Principles of Geology.* 4 vols. Ed. 3.
MACBRIDE, E. W. 1934. *Huxley.*
MARTIN C. 1873. *Introduction to New Edition of Philosophie Zoologique by Lamarck Preceded by a Biographical Introduction.*
PACKARD, A. S. 1901. *Lamarck the Founder of Evolution.*
POULTON, E. B. 1909. *Charles Darwin and the Origin of Species.*
ROSTAND, J. 1947. *Charles Darwin.*
WADDINGTON, C. H. 1952. Is the problem of evolution solved ? *The Listener*, **48**, no. 1236.
WALLACE, A. R. 1858. *Natural Selection.*
WOOD JONES, F. & PORTEUS, S. D. 1929. *The Matrix of the Mind.*

DISCUSSION

Dr. **G. S. Carter** said that he did not hold, as Professor Cannon had suggested, that Mendelian factors accounted for all the phenomena of heredity. He regarded the genes and their mutations as no more than modifiers of the course of development, and thought that some unitary system in the body to be modified by them was required. Also, to his mind, there are some types of heredity for which we have very little evidence of genetic control, for instance the more complex habits and instincts. This, however, does not imply that mutations and genes control only the trivial differences of speciation.

He thought that the reason that later zoologists had concerned themselves almost exclusively with the fourth of Lamarck's " laws " was that it alone of the four needed proof or disproof and was open to investigation. He did not think it had been disproved but that no irrefutable evidence for it had yet been adduced. He suggested that the most likely source of evidence was not from present-day experiments over a few generations, but from cases where nature has done the experiment for us over a much larger number of generations than we can use. He quoted an example from the lung-fish Lepidosiren which could be interpreted as a case where the effects of damage to the body are inherited in the undamaged body. But, even if that interpretation were accepted (and other interpretations are possible), a single such example would not constitute proof of Lamarck's law. It might be worth-while to look for other examples in nature.

Professor **A. C. Hardy** said, to begin with, I think it very important to stress what Professor Cannon himself has said in regard to Lamarck's views on the inheritance of the direct effects of the environment. So many people seem to be confused about this issue that it is well perhaps to recall what Lamarck actually said. One of his most important statements in regard to

this might be translated something like this: "Circumstances influence the form of animals; but I must not be taken literally, for the environment can effect no direct changes whatever upon their organization."* As Professor Cannon has so rightly emphasized, the essence of the Lamarckian doctrine is that a change of environment may bring about a change of habit in an animal, leading to some new want and this new want leads to the formation of some new bodily structure to satisfy it. In his second law Lamarck gives us no hint as to how such a new want might give rise to a modification in structure. It is in his third and fourth laws that he does so; there he says that the greater use and disuse of parts of the body through change in their exercise (due to change of habit) leads to their enlargement or atrophy respectively in the life of the individual, and that these effects are passed on to the next generation. Biologists, as Dr. Carter has said, have paid more attention to the third and fourth laws than to the second, because they suggest a mechanism that might be tested by observation and experiment.

I am a Darwinian, or neo-Darwinian perhaps I should say, believing in the combination of Darwinian selection and Mendelian inheritance; I must, however, add that I believe in them only as far as they go—I do not for one moment suppose that they will explain the whole of evolution. More credit should certainly be given to Lamarck than goes to him at present; in this I have much sympathy with what Professor Cannon has said. Lamarck was the great pioneer emphasizing the rôle of change of habit in evolution and I believe that this may well be found to be a far greater force in the mechanism of evolution than is allowed to-day by most biologists. I think, with Lamarck, that a new want may give rise to a new structure but I do not believe it came about by the inherited effects of use and disuse which he postulated. I believe it has come about by that particular form of Darwinian selection to which Baldwin in America and Lloyd Morgan in this country both drew attention at the turn of the century and called Organic Selection. Put into modern terms, we might describe it somewhat as follows. The gene complex is varying slightly in almost every direction; if an animal changes its habit, sooner or later there will be a new gene complex which will give a slight structural change better adapted to the fuller expression of this new habit and so will tend to survive better than the old one if the new habit is an advantageous one. For example, if birds of a particular species originally pecked insects off the surface of the bark of trees, but found in a time of shortage that they could obtain more insects by pecking into and under the bark, they might develop a change of habit which might spread through the species, just as we have seen the habit of opening milk bottles spreading through the tit populations of Europe. Now, if that change of habit became established, those birds with gene complexes which produce a beak slightly better adapted to obtaining their food in the new way, would tend to survive better than those not so well adapted. The same will apply to any other changes of habit as when an animal turns to digging for its food, diving into the water for fish and so on; in any population those gene complexes which modify particular organs to give a better expression to the new habit will, in the long run, supplant those which produced organs less efficient in satisfying its needs.

I believe that we shall come to give greater credit to the brilliant insight of Lamarck, but that the mechanism of his evolution will be found to be a form of selection. This selection, however, although made from the differing gene complexes, is one made by the organism itself and not one directly imposed upon it by the environment. Change of behaviour can bring about change of structure: a Lamarckian effect brought about by a form of Darwinian selection.

* This is a summary translation of a passage in Chapter 7 of the *Philosophie Zoologique*, 1873 Ed., **1**, p. 223.

The more usually considered natural selection brought about by the physical environment, predators, competitors, etc., must, of course, always be a very potent force—but it need not be considered as the only one that is important in the mechanism of evolution.

Mr. **E. J. H. Corner** agreed with Professor Cannon that Mendelian inheritance did not explain the inheritance of the more fundamental characters of plants, for which some " organismal " mechanism had to be postulated. Few botanists had contributed to evolutionary theory but one, A. H. Church of Oxford University, had suffered much the same fate as Lamarck. Church, in his generalized theory of plant-evolution, had shown that in plants autotrophic origin must have been particulate, and, therefore, the botanist could not follow the argument deriving organismal inheritance from amorphous protoplasm. Concerning the giraffe's neck, Mr. Corner pointed out that, in resisting breaking, plants would tend to stretch the animal's neck. [Cannon : see however footnote p. 82.

THE GREAT FOREST BELT OF NORTH BURMA

By F. Kingdon-Ward.

North Burma is the region north of the 25th parallel, wherein lie the innumerable sources of the Irrawaddy. On this definition, its southern limit lies 27 miles north of Myitkyina, at the confluence of the two branches of the Irrawaddy. These two rivers, called locally the Mali Hka (western branch) and the 'Nmai Hka (eastern and greater branch), are never more than 50 miles apart for as far north as they can be followed. The country between them is known as the Triangle. Its apex is the confluence of the two branches ; its northern base is somewhat arbitrary, but it lies south of the Hkamti Plain, in about latitude 27° N.

To the geographical botanist, North Burma is a part of the Sino-Himalayan floral region, which would include both Myitkyina and Bhamo—and perhaps the Upper Chindwin ; the main mass of Sino-Himalaya lies to the east, west, and north. In the present context, however, it is permissible to isolate North Burma from the rest of Sino-Himalaya, on the ground of convenience, without forgetting that it was originally a plateau—a part of the Tibet plateau to the north, and of the West China plateau to the east. We may call it the Irrawaddy plateau (1). This isolation is the more justified because, since the last glaciation, it *has* become comparatively isolated botanically.

North Burma, then, lies between the parallels of 24° and 28° north latitude, and approximately between the meridians 97° and 99° east longitude ; it is, in fact, a narrow strip along the western escarpment of Yunnan.

It is entirely mountainous, and is characterized by broad-leafed evergreen rain forest, sub-tropical and temperate up to 8000 or 9000 ft. capped by broad-leafed, semi-deciduous, and finally by needle-leafed evergreen, snow forest. Above 11,000 ft. the highest forest zone is capped by alpine vegetation, different not only in kind from the forest, but different in history and origin.

My wife and I spent almost the whole of 1953 north of the Irrawaddy confluence, and most of that time in the Triangle. Previous to that, I made seven expeditions into North Burma, traversing the country from north to south, and from east to west ; but though I had marched right round the hard core of the Triangle, I had never set foot inside it. I was therefore particularly glad of this opportunity to do so.

During my earlier travels I had been struck by certain geographical features of North Burma, which necessarily react on plant distribution. These significant features may be summarized thus :

(1) the north–south trend of the mountain ranges, which however do not flare out southwards to the plains, but end abruptly ;*
(2) the southward-flowing rivers. This general southward flow of all the main streams suggests an east–west alignment of the principal mountain chain, rather than a north–south one ;
(3) the inference is that the north–south ranges are not a series of crustal ruckles or geo-synclines, forced up by lateral pressure, but are the remnants of a dissected plateau.

This plateau—a lower platform, perhaps, of the Chinese plateau—may have been uplifted as a whole, and then later dissected, first by ice, afterwards by rivers, all of which flowed southwards from a great cross-range. (It is still possible to trace the general direction of this cross-range by the alignment of the high peaks on the secondary meridional ranges. This alignment is roughly east-south-east from Namcha Barwa in the eastern Himalayas (2).). Erosion, then, has played an important part in the post-glacial evolution of North Burma.

J. W. Gregory (5) has stated that the Irrawaddy valley was caused by subsidence, probably along a fault—a sort of Rift Valley. But he could hardly have been referring to the sources of the river. His view is no doubt correct for the broad, trough-like valley from Bhamo to the delta ; but the Irrawaddy above the confluence stands apart. The plateau nature of the country north of Myitkyina is indicated by the long level skylines, and by the steady decrease from east to west in the average altitudes, both of the mountain crest lines and of the river beds, showing a gentle slope westwards.

North Burma, as far south as latitude 26° and probably further, has been glaciated (3). The glaciers were derived from extensive snow fields on the plateau, and on the cross-range. There are many glaciers, snow fields, and " permanent " snow beds at the sources of the Irrawaddy to-day, and evidence (in the form of moraines, U-shaped valleys, and erratics) of their previous existence at lower altitudes, and on a larger scale.

At some period prior to the glaciation, the climate may have been wetter even than it is to-day. The small plain of Hkamti Long is an obvious lake bed, and less than 300 miles to the south-west are the Hukawng valley and the lake basin of Manipur. The Red Basin of Szechwan belongs to the same period.

All these ancient lake beds are regarded as of Pliocene Age by Gregory, and clearly belong to a pluvial phase. It may well be that the glaciation of North Burma was due partly to greater elevation, and partly to heavier precipitation—especially in winter.

As already stated, North Burma is almost entirely covered with forest of one kind or another. The several forest climates depend mainly on altitude, which determines temperature and atmospheric humidity as well as rainfall and its seasonal availability. Differences of latitude are so small as to be negligible ; but distances from permanent or semi-permanent snow are an important factor.

There are three exceptions to the general statement that the whole of North Burma is covered with forest :

(1) *the banks of the rivers between low water* (*winter*) *and high water* (*spring-summer*)

At Myitkyina the river rises and falls between 30 and 40 ft. (summer and winter), exposing considerable areas of rock and sand. This difference of level decreases steadily as the river divides and subdivides ; but remembering the hundreds of miles of waterways, it certainly amounts to a significant area of constant change. The annually exposed areas begin a few hundred feet above

* The main divide between the Irrawaddy system and the Salween continues southwards.

sea level, and are still perceptible at 6000 ft. up the larger streams ; there are always large rocks in the river beds, more exposed in winter.

It is not only that annuals immediately spring up as the river level falls in September. A variety of shrubs form a dense, even an impenetrable scrub, at—or below—high flood level ; the flora varies with the nature of the ground—rock, sand, pebbles, or mud. I have found numerous species in the river bed flora which I have seen nowhere else ; and I conclude that the river gorges afford a direct link between plains and mountains, where open spaces await colonization, and that plants make use of them for purposes of migration. They are not by any means one-way streets.

Amongst shrubs which will stand a certain amount of intermittent submergence are : *Rhododendron simsii* Planch., *Ficus pyriformis* Hook. & Arn., *Phyllanthus* sp., *Rosa* sp., *Salix* sp. Other important river bed shrubs are : *Ligustrum massolongianum* Vis, *Photinia benthamiana* Hance, *Camellia* spp., *Euonymus* sp., and, of course, *Homonoia riparia* Lour., which positively enjoys prolonged submergence.

The plant associations, when near or below high water level, vary considerably with the substratum, and so with the force of the current, which determines it. Such plants can reach only a very limited size. An undershrub usually found growing in sand, but also on pebbly beaches, is *Rhabdia lycioides* Mart. on rocks, and *Arundinella setosa* Trin. I might also mention such herbaceous perennials as *Scutellaria barbata* D. Don, *Astilbe* sp., *Viola serpens* Wall, and other characteristic plants.

(2) The second exception to the above generalization is of a different order, namely, *village sites and clearings* :

These clearings are man-made, and were quite recently covered with forest. Sometimes they are found isolated from the village, completely surrounded by virgin forest, on slopes as steep as 60°. The limit of cultivation is 6000–6500 ft., so that they only affect the sub-tropical to warm-temperate belt.

The succession which follows the abandonment of such a clearing is interesting, but need not be followed in detail here. The chief changes brought about by clearing the forest are loss of shade (only south- and west-facing slopes are cultivated), inability of the slope to retain moisture, and impoverishment of the soil. Parasitic and saprophytic fungi gradually appear on the stumps of the trees, though fire must have done a certain amount of sterilization, including no doubt, the killing of useful soil bacteria.

(3) The third and most important exception is *the mountain tops above* 10,000 *ft.* :

The area included, though discontinuous, is far from negligible. A rough calculation suggests that it may about to 5 per cent of the whole—perhaps more. These mountain tops are covered with scrub, and with alpine plants, scattered or in colonies ; but there are always many bare patches, which of course increase as we approach the limit of flowering plants. To a considerable degree the plants depend on the nature of the terrain, especially below the topmost limit ; for example, cliff faces of igneous rock, which are bare except along the joints, and screes, which are usually confined to south-facing slopes, carry few and scattered species ; but small areas of meadow carry a rich variety, as do most sheltered slopes.

The alpine zone is not only a different vegetation type, but a different floral region altogether ; and the fact that there are two distinct floral regions in North Burma—the one superimposed on the other—has certain implications. They must be of different origin, and are probably of quite different age ; and they are in contact in three dimensions, instead of in two only as on the plains.

Again, the alpine flora is isolated, not only from other alpine floras, but from itself, by weathering ; whereas the forest flora is continuous and in direct

contact with other floral regions. This difference is being slowly intensified all the time. The alpine flora is disarranged, like the chessmen towards the end of a game of chess.

The mountain scrub vegetation is mainly composed of a few families and of few genera, the best represented being *Rhododendron*. (There are at least 17 species recorded.) Others are *Berberis*, *Lonicera*, *Cotoneaster*, *Salix*, *Rosa sericea* Lindl. or *R. omeiensis* Rolfe, *Prunus mugus* Hand-Mazz., "*Sorbus pygmaea*" (or *S. reducta* Diels). The only conifer known to me is a species of *Juniperus*.

The more extensive *herbaceous* alpine flora is Himalayan and European, perhaps also Arctic, in its relationships. It is a local variation of the Sino-Himalayan arctic-alpine vegetation, which occupies so much of mountainous South-East Asia. It includes most of the endemic genera such as *Meconopsis*, *Nomocharis*, *Notholirion*, *Cyanthus*, *Cremanthodium*, *Bolocephalus*, *Ligularia*, and other *Compositae*, etc.

Our route into the Triangle from Myitkyina followed the cart road up the valley of the western Irrawaddy, by way of the confluence, as far north as Sumprabum. We travelled by jeep, taking over two days to do the 130 miles. The journey can be made in one long day. Our heavy baggage followed in bullock carts, which took ten days or a fortnight.

The road keeps to the hills west of the river. By the 50th mile we had the Kumon range (forming the watershed between the Irrawaddy and the Chindwin) visible to the west, and a higher range across the western Irrawaddy, forming the eastern skyline, to the east. The latter range is the watershed between the two main branches of the Irrawaddy, and the backbone of North Burma. As far north as Sumprabum its crest line is unbroken, and often level for long distances; the contours are smooth and regular, the altitude rarely exceeding 8,000–10,000 ft. above sea level. It is the same with the lower ridges between the river and the main watershed, which form a series of steps up to it.

In about latitude 27°, however, the crest lines of the main watershed and of several adjacent ranges suddenly rise in a number of high rocky peaks to almost 12,000 ft. These ridges overlap, and the peaks, seen from the west, are arranged in echelon at the source of a left-bank tributary called the Hkrang Hka. These peaks were our objective.

When we reached Sumprabum early in January, they were still under winter snow, and though 50 miles distant, were very conspicuous on the north-eastern horizon.

Towards the end of March 1953 we set out on foot for Hkinlum, a village situated at the foot of the main watershed, midway between the two highest peaks on the range. It took us eleven days, excluding halts.

Crossing the Mali Hka, we entered the Triangle; and halting at two or three villages *en route*, reached Hkinlum on 7 April. This journey diagonally across from the Mali Hka, 1200 ft. above sea level, and eventually to the crest of the main watershed, whence we looked almost straight down on to the 'Nmai Hka, gives a fair cross-section of the North Burma forest zone. Between the extremes of 1200 ft. and 12,000 ft. above sea level, we crossed six or seven lower ranges in ascending order, and met with almost every type of forest found in North Burma, except *Tsuga* and *Pine* forest. Indeed, the lack of conifer forest in the lower zones was remarkable.

We can conveniently recognize three belts:

(1) sub-tropical broad-leafed evergreen rain forest up to 6000 ft.;
(2) temperate semi-deciduous broad-leafed rain forest, 6000–9000 ft.;
(3) evergreen coniferous or sub-alpine snow forest, passing gradually into alpine scrub, 9,000–11,000 ft.

Hkinlum is only 4000 ft. above sea level—the same altitude as Sumprabum;

but being in contact with the winter snow-clad peaks, it has a more temperate forest flora. Nevertheless, the majority of Sumprabum species occur, if in fewer numbers.

Notable *absent* trees are : *Aesculus punduana* Wall., *Eriobotrya bengalensis* Hook. f., *Shorea assamica* Dyer, *Dipterocarpus tuberculatus* Roxb., *Terminalia myriocarpa* H. & M. *Manglietia caveana* Hook. f. & Thom, and *Duabanga sonneratioides* Buch-Ham.; also species of *Eugenia, Meliosma, Melodorum, Clerodendrum,* and *Styrax*. Other species take their place, as *Acer campbellii, Myrica nagi* Thunb., *Michelia bailloni* F. & G., *Cephalotaxus mannii* Hook. f., and *Podocarpus imbricata* Bl., besides many other trees and shrubs not found at Sumprabum. A majority of species at comparable altitudes are common to both areas ; *that is to say, fundamentally it is one flora.*

(1) Sub-tropical forest is seen at its richest in ravines and other sunless places. It is characterized by a considerable variety of broad-leafed evergreen trees, a wealth of ferns, many of them of large size, a few small palms, including species of *Calamus,* and *Pandanus* spp., and an abundance of sub-tropical or warm-temperate families.

Aroideae are conspicuous on the Myitkyina-Putao road and beyond. They include *Raphidophora, Cryptocoryne, Arisaema, Typhanum, Lasia, Amorphophallus, Colocasia, Scindapsus, Pothos.* Species of *Arisaema* are found up to 8000 ft. But Ridley says that in Malaya (20° further south) they disappear at about 4000 ft. Thus the genus seems to be of temperate origin. *Cryptocoryne,* a genus found in river beds, may have travelled up the gorges—or down. *Zingiberaceae* are also prominent, at least as far north as 27° 45′ and up to 8000–9000 ft. On the Mungu Hkyet (pass) at this altitude I found an unnamed species of *Cautleya.* Similarly *Gesneraceae* (*Didymocarpus, Chirita*) abound, especially between 2000 and 4000 ft.

It might be as well to emphasize some of the common and often locally dominant tree species—the two or three Dipterocarps, *Annonaceae, Lauraceae, Magnoliaceae, Myrtaceae* (*Eugenia*), *Ficus, Elaeocarpus, Albizzia,* and many more. Though poorer in species and less tall than the tropical rain forest, it fits in well with the excellent descriptions of Schimper(6), and lately of P. W. Richards(7), and is recognizably the same plant formation " in reduced circumstances ". It lacks, however, two typical attributes : cauliflory, and mainly (though not entirely) " plank buttresses ", neither of the first importance. There are a few deciduous species, like *Rehderodendron.* No doubt there is an equivalent belt all along the Himalayas, at least as far as western Nepal.

Undergrowth is abundant and various, except where bamboo is dominant. At Hkinlum a species of *Chloranthus* was often seen, together with ground orchids.

(2) Less is known of the *temperate* rain forest belt of North Burma than of most of the world's forests ; nearly 100 endemic species have been described. Its nearest equivalent occurs probably in Sikkim, only 600 miles to the west and in the same latitude. Richards has pointed out the common features of the tropical rain forest belt right round the equator ; and a similar temperate forest belt existed round the world in pre-glacial times, as Mrs. E. M. Reid has clearly shown(8). It is less clear what has happened *since* Miocene or Pliocene times in South-East Asia.

In many respects the temperate rain forest of North Burma agrees with the definition of rain forest in general ; that is to say, the great majority of the plants are *woody,* and are *trees.* Many of the climbers and epiphytes are also woody. The forest is still mainly evergreen, but deciduous species gradually increase in number and variety as we ascend—magnolias, maples, cherries, birch, *Sorbus,* and others. In one important respect, however, temperate rain forest departs widely from tropical rain forest. Richards writes : " The tropical

rain forest . . . as a community, has no marked seasonable 'aspects' and no 'resting period'." Temperate rain forest has both—a spring "aspect" brilliant with breaking leaf buds of all colours, and of "flowering" trees, notably rhododendrons and magnolias; and a winter resting period gay with late flowering trees, and with some autumn coloured foliage.

At the lowest level are trees as tall as any in the sub-tropical zone (e.g. *Taiwania cryptomerioides* Hayata). But in general they are shorter, much branched, with spreading rounded crown, giving them a rather squat appearance: though not a few are fair-sized trees up to 25 m. high with conspicuous trunks. On the other hand, *Rhododendron sidereum* I. B. Balf., though it may be 200 or more years old, hardly attains 15 m., with a short or divided trunk, imposing only for its girth and the great crown of branches it carries.

In the lower half of the zone a number of outstanding trees are met with, including many primitive species: *Gordonia axillaris* D. Dietr., *Schima crenata* Korth., *Actinidia callosa* Lindl., *Rhodoleia*, *Wightia*, *Helicia*, *Decaisnea*, and others, together with oaks and chestnuts (*Castanopsis*).

At higher levels, around 8000–9000 ft., more familiar trees predominate, like cherries, maples, *Ilex*, and *Sorbus*, together with *Magnoliaceae* (*Magnolia nitida* W. W. Smith, and *M. rostrata* W. W. Smith), oaks, birch (*Betula utilis* D. Don.), *Zanthoxylum*, *Tetracentron*, and most spectacular of all in flower, primitive tree-Rhododendrons.

However, though it sound paradoxical, one of the most noticeable features of the temperate rain forest is the groups of incidental plants which do not belong to the dominant growth form. There are several categories of plants, typical of rain forest in general, which (as Schimper says) "belong to many formations without ever forming one of their own". They have a common habit, or mode of growth; but are not otherwise any more closely related than are the trees of the forest.

Schimper recognizes four such guilds, namely: lianas, epiphytes, saprophytes, and parasites. But if the last two are included, then one should also recognize the forest undergrowth as a fifth guild.

Lianas are mainly dependent for their existence on temperature.

Epiphytes are mainly dependent on moisture, especially on atmospheric moisture.

Forest undergrowth is mainly dependent on light (that is to say, light intensity).

As for parasites and saprophytes, they are entirely dependent on other life for their existence, and are an incidental part of every plant formation. Rain forest—tropical or temperate—has no monopoly of them.

From what I have said above, we may conclude that lianas are most abundant in the sub-tropical zone, epiphytes and forest undergrowth (flowering plants) in the temperate zone. Above 6000 ft., woody climbers fall off rapidly though they still occur, as *Actinidia*, *Lonicera*, *Jasminum*, *Calamus*, *Holboellia*, *Schisandra grandiflora* Hook, f. & Thoms, *Clematis montana* Buch.-Ham., and others.

Epiphytic undershrubs, however, are numerous, reaching their maximum development possibly in the warmer half of the temperate zone. Here are species of *Agapetes*, *Aeschynanthus*, *Vaccinium*, *Hymenopogon*, *Rhododendron*; besides a great variety of herbaceous species, and of ferns, lycopods, and mosses. Amongst notable species are the tropical-looking *Begonia hymenophylloides*, *Utricularia*, *Hymenophyllum*, *Luzula*, and many orchids (*Coelogyne corymbosa* Lindl., *Diphylax urceolata* Hook., f.), *Zingiberaceae*, etc.

Almost any tree will bear epiphytes, and most are covered with them. The only major exception seems to be *Rhododendron*, which rarely carries even a little moss. Deciduous trees are not much favoured either (e.g. maples).

The temperate forest undergrowth consists mainly of monocots and ferns, though there are also dicots. The monocots include orchids (*Calanthe*, *Anectochilus*), *Liliaceae*, *Araceae* (*Arisaema*), *Zingiberaceae* (*Globba*, *Hedychium*), with one or two *Cyperaceae* ; but few species are confined to this type of forest.

The Dicotyledons include several species of *Begonia*, besides *Primula*, *Chirita*, *Didymocarpus*, *Hedyotis*, *Sporoxeia*, *Podophyllum*, *Berneuxia*, *Elatostema* (often gregarious), and others.

Shrubs also are scattered through the forest undergrowth in some variety, but are concentrated on exposed ridges ; *Wikstroemia*, *Ardisia*, *Mahonia* (dwarf), *Ribes*, *Leycesteria gracilis* Kurz, *Euonymus*, *Hydrangea*, *Edgeworthia gardneri* Meissn., and many more. It is particularly interesting to find sub-tropical (or at least warm-temperate) genera such as *Symplocos* (*S. dryophila* C. B. Clarke), *Rehderodendron*, *Helicia*, and *Elaeocarpus*, and families like *Lauraceae* (*Lindera sericea* Blume, *Cinnamomum* sp.) striving upwards into the temperate zone, sometimes even into the snow.

In some parts of North Burma the temperate zone includes a stratum of conifers, *Picea* and *Tsuga* ; but not, so far as our experience went, in the Triangle.

(3) The topmost forest zone is quite different from anything below. It is evergreen snow forest (as opposed to rain forest) with a single dominant tree—*Abies delavayi* Franch (or *A. densa* Griff.)—throughout, and one or two dominant tree-Rhododendrons (usually *R. arizelum* I.B.B. & F. and another). *Larix* sp. may occur scattered.

From a little distance, broad-leafed forest is easily distinguishable from conifer forest by its colour, and the tree line itself is sharp. Thus, although sub-tropical forest passes quite gradually into temperate forest, and temperate broad-leafed rain forest into evergreen coniferous snow forest, sub-tropical forest is as distinct from snow forest as forest is from grassland and desert. I don't think Schimper's three contrasting vegetation formations are enough ; there are certainly two major forest formations—rain forest and snow forest—making four climaxes rather than three.

There are no lianas in the topmost forest zone ; but epiphytes, though greatly reduced in numbers and variety, persist. Moss and lichen increase on the trees, and several undershrub Rhododendrons (*R. micromeres* Tagg) occur almost to the tree line. It is surely remarkable that even *Hymenophyllum* is found at 9000 ft. ; but, of course, we have one or two species in England also.

At low levels it makes very little difference to the flora whether a slope faces north or south ; but as one ascends, the difference becomes more and more marked, until at alpine level there is not merely a wide variation in the flora, but the vegetation type itself may be different for almost 1000 ft.—forest on the north (sheltered) slope, alpine on the south. This is not so much a question of different light intensity, or of temperature, but of water derived from snow-melt in the spring. However, this is indirectly a difference of sunshine and temperature.

Whence was the North Burma forest derived ? There is an undoubted east-west relationship with Japan, Formosa, and the China coast on the one hand, and with the Himalayas on the other. This forest flora, according to Mrs. E. M. Reid, once spread from the Atlantic to the Pacific, through Europe and Asia, and across North America. She writes : " The Pliocene Epoch in western Europe had witnessed the existence and extinction of a flora closely allied to the living floras of the Far East in Asia, and of North America, and in whatever part of the northern hemisphere these plants or their nearest relatives . . . were found in lower latitudes, they were nearly always mountain plants."

She goes on to describe how in Europe and western Asia this flora was exterminated ; whereas in North America and in eastern Asia it escaped southwards (though in the latter she allows little enough room for it to do so).

It seems more probable, however, that in the eastern Himalayan (North Burma-West China) region, this forest has always been there, at least since Miocene times. It never was driven out entirely. If we accept that, we are not concerned with any pressures which moved the Eastern Asiatic flora eastwards or westwards, but only with what disrupted it.

I will give only one example of that disruption here, viz. *Taiwania cryptomerioides* Hayata. This tree was discovered in Formosa just 50 years ago, and a few years later it turned up in North Burma, where it is one of the mightiest trees in the forest. The disjunction was about 1800 miles. Recently, however, it has been found in central China, giving two disjunctions of some 800-900 miles each.

What would the palaeobotanist make of an assemblage of fossil leaves and fruits from this forest ? He would find very large leaves like *Magnolia rostrata* W. W. Smith and *Rhododendron sinogrande* I.B.B. & W. W. S., mixed with the extremely small leaves of *Ilex crenata* Thunb. and *Gaultheria nummularioides* D. Don. ; leaves with long drip tips like *Ficus* sp., *Acer* sp., *Castanopsis*, *Ilex*, *Prunus*, and *Quercus pachyphylla* Kurz. ; but still more species *without* drip tips. Compound leaves with small leaflets (like *Sorbus*) or large (like *Schefflera*), together with very many simple leaves. And if we could identify them, leaves of *Styrax*, *Rehderodendron*, *Symplocos*, and laurels— indicating a warmer climate—as against *Viburnums*, *Rhododendrons*, *Ilex* and *Sorbus* (*Aria*)—indicating a cooler one !

Of seeds and fruits, he would find *Polygonum* and *Zanthoxylum*, *Magnolia*, *Castanopsis*, possibly *Acer*, and many others. One might expect *Rhododendron* fruits as well as leaves, but for the fact that they appear to be non-existent in any fossil remains ! The only *Rhododendron* identified in the fossil state appears to be *R. ponticum* Linn. (leaves only) in half a dozen stations in Europe, which is surely curious.

Do mountain floras offer a poorer chance of preservation than plains floras ? Leaves, fruits, and twigs are regularly flushed down mountain scuppers, and come to rest often far from their place of origin, within the zone of a different forest type, or even a different floral region. In this respect at least, they may mislead the palaeobotanist, who is apt to confuse plants from very different altitudes.

Recently I was working on the distribution of plants eastwards and westwards from Rima. This district is just inside Tibet, on the flank of the escarpment, but south of the great divide (latitude 28° 30′, longitude 97° 0′). The majority of species ranged from the Himalayas eastwards deep into China ; but a few were known *only* from the east, or *only* from the west. Anyway, this east-west relationship was well known to Hooker ; but it has been extensively ruptured since Miocene or Pliocene times.

The other unmistakable relationship of the North Burma forest flora is a north-south one, such as that envisaged by Mrs. Reid. Here much is in favour of a southward migration of the flora, and perhaps its return—river valleys and mountain ranges run in the most convenient direction, and the Pleistocene glaciation might provide the necessary driving force, as in Europe and America. However, the Greenland ice-cap can hardly have affected places as distant and as far south as Burma.

It is customary, amongst British geographical botanists at any rate, to play down the effect of the Pleistocene glaciation in Siberia. Thus Good writes : " . . . the great Polar ice-cap of the Pleistocene was not . . . symmetrical about the present North Pole, but had its centre in what is now the southern part of Greenland. As a result, the ice reached particularly low latitudes in eastern North America and in Europe, but covered only the northern edges of Asia and in fact made itself felt there little more than does the ice-cap today."(9)

It would seem, however, from the work of the Russian geologists that most of Siberia itself was heavily glaciated during the Pleistocene. Thus the American glaciologist Paul D. Krynme writes : " In conclusion, it seems that possibly all of Siberia north of the 61° parallel, and certainly at least two-thirds of it was covered with Pleistocene ice, which coalesced east and west with the American and European glaciers, forming, according to Urvantsev, a ' gigantic ice ring ' within the northern hemisphere."

However, the southern limit of the " ice ring " was still 2000 miles distant from the nearest areas known to be rich in alpine plants and high conifer forest ; though it is hard to believe that great areas lying between the " ice ring " and known Sino-Himalayan glaciation were not also affected. The latitude is comparatively low, but the altitude is, and was then, high.

But in all these suspected cases of extensive glaciation, it is necessary to bear in mind the direction of the rain-bearing winds. If these were, for any reason, cut off, or diverted, neither high latitude nor high altitude would alone suffice for glaciation. But perhaps the Siberian glaciation is of more direct significance to the movements of the alpine than of the forest flora.

Perhaps only the Sino-Himalayan glaciation itself would have affected Burma and the adjacent regions which belong to Sino-Himalaya. Gregory certainly underestimated this glaciation, which was much more intense, and covered a much greater area, than he knew ; but he was probably correct in saying that there was no real ice-cap here, and that some areas were free of ice—though possibly, as in Siberia, many small centres of glaciation were active at the same time.

It is, of course, tempting to believe in a southern drive, as in Europe and North America ; but several arguments strongly suggest otherwise.

In Miocene and Pliocene times, in these comparatively low latitudes, the climate was warm and sunny, and it would need a very considerable climatic change to bring about such an exodus as took place in the cold-temperate north.

It seems pretty certain, however, that the *alpine* flora took a trip south for its health ; but the forest belt may have been little affected.

A more cogent argument against any large migration, it seems to me, is that the southern peninsulas, commonly regarded as reception centres for the refugees, were already filled with a rich tropical vegetation. Botanists talk too glibly of one flora being telescoped into another. It is that seductive metaphor " telescoped " which is so fatal. I think the tropical flora would have strongly resisted a mass migration from the north. To put it bluntly : is it likely that a fleeing rabble of plants, crippled and disorganized in the cold war, could find niches further south which a virile flora, stable for a million years, would have overlooked ? Frankly, I don't believe in this " telescope " theory, except as a slight infiltration. Plants move into *open spaces*, not into closed formations. They migrate northwards from the tropics ; and up the mountain ridges and valleys from the plains ; also up into the forest canopy from the forest undergrowth as epiphytes.

The Malaysian element in North Burma can be accounted for fairly enough by a northward migration from the tropics. And indeed, what more natural than that there should be a continuous exodus from the crowded ghettos of Malaysia into the wide open spaces of Sino-Himalaya ? The open spaces, caused by the retreat of the glaciers, and by the repeated earthquake shocks along the main boundary fault, are there waiting. The country sterilized by the great earthquake of 1950, for example, on the Assam–Tibet frontier, seems almost incredible.(4)

As an example of discontinuous north-south distribution there is *Podocarpus imbricatus* Blume ,well known in Malaya and Indonesia. In 1953 we discovered specimens in North Burma, where it was said to have been common a few years

ago. The disjunction between the Triangle, and the peninsular northern station of *Podocarpus imbricatus*, is about 800 miles. But many trees are found with no considerable break from the equator to 28° in North Burma.

The efforts of sub-tropical genera to mountaineer and establish themselves in temperate and even in sub-alpine zones in North Burma, points to this same urge to escape from the crowd into the fresh air; northwards in latitude and upwards in altitude.

We found such genera as *Styrax*, *Rehderodendron*, *Daphniphyllum*, and *Elaeocarpus*, not to mention laurels, in the upper temperate forest. *Lindera sericea* Blume grows at 9000 ft., and *L. sikkimensis* Meissn. is also found in North Burma. Conversely, alpines press downwards, and one frequently finds hardened alpines far below the tree line, particularly in gullies. A species of dwarf Cornus (*Chamaepericlymenum*) like *C. suecica* Linn. found in the forest at 9000 ft., will serve as an example.

That the Sino-Himalayan glaciation was nevertheless severe is suggested by the sudden extinction of the Siwalik mammalian fauna, as remarked by Wadia.(10) He attributes the observation to A. R. Wallace. But that was in the north-western Himalaya. Personally, I should be more impressed if someone pointed out an extinct flora, preferably in the eastern Himalaya. There is a fossil flora, with leaf impressions, in the sandstone rocks at Mython Ga, mile 107 on the Myitkyina-Putao road; but it has never been properly examined.

Thus I conclude that the North Burma forest has had a respectable lineage; that it is, in fact, a Miocene reserved forest, which has changed little since mid- or early-Tertiary times. I draw a distinction between the forest and alpine floras, the origin of the latter being still far from clear, though it must have been greatly influenced during the Ice Age.

A vast amount of work remains to be done on the North Burma flora, both in the field and in the herbarium; and this includes field work on the evolution of the mountain and river systems and on the Ice Age, together with possible arid and pluvial periods.

References.

(1) Kingdon-Ward, F. 1939. The Irrawaddy plateau. *Geogr. J.*, **94**, 293–308.
(2) ——. 1934. The Himalaya east of the Tsangpo. *Geogr. J.*, **84**, 369-397.
(3) ——. 1943–5. A sketch of the botany and geography of North Burma. *J. Bombay Nat. Hist. Soc.*, **44**, 551-574; **45**, 16-30, 133-148.
(4) ——. 1953. The Assam earthquake of 1950. *Geogr. J.*, **119**, 169–182.
(5) Gregory, J. W. & C. J. 1925. The geology and physical geography of Chinese Tibet and its relationship to the mountain system of South East Asia. *Phil. Trans.* (*B*), **213**, 171-298.
(6) Schimper, A. F. W. 1903. Trans. Fisher, W. R. J. *Plant Geography*. 1903.
(7) Richards, P. W. 1953. *Tropical Rain Forest.*
(8) Reid, E. M. 1920. A comparative review of Pliocene Flora. *Quart. J. geol. Soc.*, **76**.
(9) Good, R. d'O. 1953. *The Geography of the Flowering Plants.* Ed. 2.
(10) Wadia, D. N. 1937. *Geology of India.*

A FURTHER NOTE ON EDWARD MORGAN AND THE WESTMINSTER PHYSIC GARDEN

By R. H. Jeffers.

An account has been given (Jeffers, 1953) of Edward Morgan (fl. 1639–85), and the Westminster Physic Garden of which he was Herbarist, or Gardener, from about 1650 until about 1678. Since the publication of that account some further facts have come to hand which deserve record. They concern firstly,

two coniferous trees grown by Morgan, and, secondly, material which identifies clearly the garden in Westminster, the remainder of the lease of which, the Society of Apothecaries took over in 1676.

The list of plants prepared by the Rev. Thomas Lawson during his visit to the Westminster Physic Garden in 1677 included *Pinus pinaster* Soland. in *Ait. Hort. Kew*, **3** (1789), 367, and this plant was probably raised or planted in the Westminster Physic Garden during Morgan's tenure of office, i.e. between 1650 and 1677. The Rev. John Ward visited the Garden several times from 1661 onwards, and John Ray paid visits in 1662 and 1668, but neither of them has left any record of having seen the tree. Samuel Doody (1656–1706), must be added to the list of visitors to the Westminster Physic Garden. Born in Staffordshire, he was apprenticed in London as an apothecary under his father. This apprenticeship may have commenced about 1670, when he was 14 years of age, in which case it would have expired about 1678, so that in pursuing the necessary botanical studies required of an apothecary he could have visited Edward Morgan at the Westminster Physic Garden during that period.

About the time Doody's apprenticeship ended, Morgan left both the Garden and Westminster. He was succeeded as Gardener by Mr. Rusholm, who held the post until towards the end of the year 1687, when the plants were dispersed and the Garden closed. Doody could have had access to the Garden at any time between about 1670 and 1687.

Having qualified, Doody practised as an apothecary in the Strand, Westminster; by 1682 he was a friend of John Ray, who, early in that year began writing the first volume of his *Historia Plantarum*. It was published in June 1686, and while this first volume was being written, Ray had begun to compose the second one, the text of which he completed by September 1687, thereafter busying himself with the Index and Preface. This second volume of the *Historia Plantarum* was published early in December 1687, though the colophon on the title page bears the date 1688 (Keynes, 1951). The appearance of this volume and the closing of the Westminster Physic Garden thus occurred in the same year, and perhaps about the same time. Now, the second volume of Ray's *Historia Plantarum* contains a lengthy Appendix, which, together with the rest of the text, was seemingly completed by Ray by September 1687 (Raven, 1942), and in it he referred to plants collected by Doody, among them being a specimen of a coniferous tree which he described (Ray, 1688) under the name :

Abies foliis praelongis Pinum simulans.

This is *Pinus pinaster* Soland., a plant of which Thomas Lawson had seen growing in the Westminster Physic Garden in 1677. Ray stated that Doody, who was very well known to him as an apothecary and botanist of London, had sent him a little branch of the fir-tree, which he then described, and concluded by saying that Doody wrote of it only in the garden of Mr. Edward Morgan, in Westminster, where it had been raised long since and called *Pinaster*.

As the text of the second volume of the *Historia Plantarum* was composed by Ray between 1682 and September 1687, he may have received Doody's specimen during that period—perhaps towards the end of it. If so, then Doody may have collected it in the Westminster Physic Garden at the time when Mr. Rusholm was Gardener.

Ray's reference to the plant suggests that he was not personally acquainted with it. Had it been raised after Ray's second visit in 1668, its maximum age in 1687 would have been 19 years, time enough for it to have produced a little branch of which a specimen could be taken. The tree was, probably, rather older than this and Edward Morgan almost certainly raised or planted it.

Dr. Leonard Plukenet was the next author to make any reference to *Pinus pinaster* Soland. He had assisted Ray in the preparation of the second volume of the *Historia Plantarum*, and in 1691 he was living in Old Palace Yard, Westminster, quite close to the Westminster Physic Garden, which he had visited in Edward Morgan's time. He now began the publication, at his own expense, of the several botanical works bearing his name, the first of which appeared in 1691, and the last in 1705. Plukenet not only named, but also figured *Pinus pinaster* Soland. (Plukenet, 1691), and the specimen depicted by him might well be similar to the little branch which Doody gave to Ray. Plukenet identified the plant with the *Abies Pinum referent foliis ex omne parte prorumpentibus* which Caspar Bauhin had described in his *Pinax*, and it was Plukenet who assigned Ray's name to Bauhin's plant as a synonym. Five years later Plukenet gave a fuller synonymy of the plant (Plukenet, 1696), and added that a specimen of this elegant fir had been sent to him by Tancred Robinson, M.D., from the Leyden Botanic Garden.

John Ray died in 1705, Doody and Plukenet in 1706, and Ray's description of *Pinus pinaster* Soland. was next noticed in 1740 when Philip Miller referred to it in the Abridged Edition of *The Gardener's Dictionary* (Miller, 1740). In this edition he described four species of *Abies*, the first of which was :—

> " Abies foliis praelongis pinum simulans. Raii Hist. Firr tree with long leaves resembling those of the Pine-tree."

Of this he observed :—

> " These [four] Sorts are, at present, very rare in England : the first was formerly growing in the Garden of Mr. Edward Morgan in Westminster a Branch of which Tree was given to Mr. Ray by Mr. Doody, a very curious Botanist."

Pinus pinaster Soland. was first referred to in England in 1597 (Gerard, 1597). Many years later it was described and figured by Aylmer Bourke Lambert, who, in his *Description of the Genus Pinus*, **1** (1803) tt. 4 et 5, observed :

> " The first Pinus Pinaster planted in England was in Bishop Compton's garden at Fulham, and is still [1803] growing there in a healthy state. Tab. 5 is copied from a drawing by Ehret, in the possession of Sir Joseph Banks, by whom it was purchased, together with drawings of several other species of Pinus at the sale of Mr. Moore's effects in Shropshire."

The " Mr. Moore " referred to was Robert More, F.R.S. (1703–80), who, after graduating at the University of Cambridge, studied for a while at Leyden University, eventually returning to England where he settled at the family home, Linley Hall, Shropshire. He was apparently keenly interested in planting coniferous and hardwood trees, and was one of the earliest planters of the European Larch (*Larix europœa* DC.) in Britain. During the rebuilding of Linley Hall he travelled in Sweden, about the year 1775, and it was on this occasion when he met Linnaeus.

It is a moot point whether Bishop Compton was the first to plant *Pinus pinaster* Soland. in Britain. He was appointed Bishop of London in 1675, so he could not take up residence at Fulham until then. His plantings there commenced after that time, but Edward Morgan had almost certainly raised or planted a tree before 1675. While the Bishop's specimen may have come to him from the Westminster Physic Garden by the agency of his friend Dr. Leonard Plukenet, it is equally possible that Plukenet's agency may have been the means of supplying specimens both to the Fulham and the Westminster Gardens. In that case, the source of the seeds or plants may have been the

Botanic Garden at Leyden, whence Plukenet is known to have received a specimen of the tree.

As a commentary on the scarcity of *Pinus pinaster* Soland. in Britain in 1740 to which Miller referred, there is a record (Elwes & Henry 1910) that J. B. Petre, Esq., planted over 200,000 trees raised from his own seed from trees planted at Westwick, Norfolk, about 1702.

Concerning the first and second volumes of Ray's *Historia Plantarum* it should be noted that they were both reissued without a change of title page in 1693 (Pritzel, 1851 et 1872). In the first edition of volume two, published in 1688, page 1944 is marked "1940" (Keynes, 1951). Linnaeus's own copy, now in the Linnaean Library, was of the 1693 impression, and the same misprint occurs in it. Miller's *Abridged Edition of the Folio Edition* of his *Gardener's Dictionary* was not only an abridgment of that work, but, as several articles in it show, it was also a supplement to the folio work.

The second coniferous tree grown by Edward Morgan in the Westminster Physic Garden was mentioned by Philip Miller in later editions of his *Dictionary* (Miller, 1759 et 1768).

In the seventh edition, published in 1759, he described a plant under the name :—

> "Abies maxima sinensis, pectinatis taxi foliis, apiculis non spinosis Pluk. Amalth. Greatest China Fir Tree with Yew Leaves not prickly at their points."

Of it he wrote :—

> "[this] the eighth was formerly growing in the Garden of Mr. Edward Morgan in Westminster, a Branch of which was given Mr. Ray by Mr. Doody, a very curious Botanist, but this Tree has been destroyed many Years ago."

In the eighth edition of the *Dictionary*, published in 1768, Miller again referred to the tree :—

> "There was also many years past a tree of the China Fir growing in the garden of Mr. Morgan of Westminster, which is mentioned by Dr. Plukenet, but being in a bad situation it made little progress, the smoke of London being very hurtful to all sorts of evergreen trees : but whether it was killed in that garden, or removed to any other, I do not know, for the ground has been built upon many years."

The plant thus referred to by Miller, was described and figured by Dr. Leonard Plukenet, whose figure shows a leafy twig without cones (Plukenet, 1705). This illustration is one of several on a plate which was engraved by the English engraver and printseller, Robert Spofforth, who flourished in 1707 (Williamson, 1934) and the specimen depicted very closely resembles *Picea likiangensis* (Franchet) Pritzel, a species native to Yunnan, in Western China. The apical buds and the shape of the leaves depicted in Plukenet's figure are identical with the figure of *Picea likiangensis* (Franchet) Pritzel in W. Dallimore & A. B. Jackson's *A Handbook of the Coniferae, including Ginkgoaceae* (1923), p. 335, fig. 73. There can be little doubt that *Picea likiangensis* (Franchet) Pritzel was grown by Edward Morgan in the Westminster Physic Garden sometime before 1678.

Such an early record of the cultivation in Britain of a Yunnanese plant naturally arouses speculation as to the manner of its importation. A possible explanation could be provided if it is remembered that Dr. Leonard Plukenet had several contacts with merchants and seamen trading and sailing to the Far East.

The possible connection of Edward Morgan and the Westminster Physic Garden with the Society of Apothecaries and the Chelsea Physic Garden was

discussed (Jeffers, 1953) in the light of the information then available. The tentative conclusion was reached that the remainder of a lease of a garden in Westminster taken over in 1676 from Mrs. Gape by the Society of Apothecaries was not that of the Westminster Physic Garden, and this can now be confirmed. On the other hand the hypothesis that Mrs. Gape might have let a portion of the Physic Garden to Edward Morgan cannot be sustained.

In the summer of 1672 the Society of Apothecaries elected as Master, Mr. William Gape, who practised his profession in the parish of St. Paul's, Covent Garden, London. Born in the parish of All Saints, Dorchester (Hutchins, 1774) he died in October 1675, and was buried in the Church Porch of St. Paul's, Covent Garden, on 9 October 1675 (Hunt, 1908). His Will (Ainsworth, 1942) was dated 3 October 1675 and proved on 20 October 1675 by his friend Alexander Denton, of the Middle Temple, and his cousin, Francis Bostock, of the Inner Temple. It refers to his house in Pall Mall, and divides his property between his wife, Mary, and his two brothers, with remainder to his nephews and nieces. There were bequests to Alexander Denton and Francis Bostock, his Executors, and to Francis Gape, his cousin. There is no reference to property in Chelsea, or in the parish of St. Margaret, Westminster, wherein the Westminster Physic Garden was situated. Neither the Garden, nor Edward Morgan is mentioned, and the name Gape does not appear in the *Books of Accompt of the Overseers of the Poor of the Parish of St. Margaret's, Westminster.*

Mrs. Mary Gape survived her husband and died in November 1681. Her Will (Ridge, 1948) revoking one dated 13 August 1680 was dated 16 November 1681, admon. d.b. being granted on 4 July 1692. It makes no reference to property in Chelsea, or in the parish of St. Margaret, Westminster. There is no reference to the Westminster Physic Garden, or to Edward Morgan. These facts appear to exclude both William Gape, and Mary Gape, his wife, from any connection with Edward Morgan or the Westminster Physic Garden. Yet it is certain that the Society of Apothecaries did take over the lease of a garden after the death of William Gape, and the garden concerned was that of their late Master, William Gape, himself, and it was probably situated behind his house in Pall Mall, in the parish of St. James's, Piccadilly.

This is made clear following an examination of entries in the Court Minute Books of the Society of Apothecaries which elicited the facts here summarized.

On 13 June 1676 the Master read to the Court an account drawn up by [the late] Mr. [William] Gape, Dr. [Alexander] Denton, and Mr. Morgan about the plants in Mr. Gape's garden. It was offered the Company to " enjoy " the plants and the garden for one year and three-quarters, from Midsummer Day, 1676, on condition of a payment of £16 to Mr. Bayles [or Bales]. Mr. Morgan " threw himself on the Company for his interest ". The Court agreed to pay the £16 to the landlord [evidently Mr. Bayles], to lease the garden for one year and three-quarters, to take over the plants and to remove them to the Company's own garden at Chelsea. The lease was due to fall in on Lady Day in March 1678.

Dr. Denton mentioned in the minute was evidently Alexander Denton, one of the Executors of the Will of William Gape.

On 24 April 1678 the Court of Assistants ordered the Clerk to go to Mr. Morgan concerning the £16 paid for " Morgan's garden ", and tc see if he could prevail on him to pay the money, or provide plants in lieu of the money.

Now, the lease of William Gape's garden held by the Society had fallen in on Lady Day in March 1678—a month before this entry in the Minute Books. The suggestion offered by it is that Mr. Morgan had replaced the Society as a lessee of the garden. They may have advanced him £16 with which to acquire the lease, and now sought repayment, or plants in lieu of the money.

These entries do not identify Mr. Morgan, who, on 13 June 1676 had acted

in a consultative capacity and therefore depended on the Company for his "interest". It is improbable that the Mr. Morgan concerned was Edward Morgan of the Westminster Physic Garden. The surname Morgan was not uncommon in London and Westminster at that time.

The Minute Books also record that on 21 January 1679–80, Mr. John Watts, a member of the Society of Apothecaries, was ordered to "undertake the ordering, management and care of ye company's Botanick Garden att Chelsea". He succeeded Mr. Pratt. He was erroneously styled James Watts (cf. Jeffers, 1953) under which name, and as Charles Watts he has appeared in the literature relating to the Chelsea Physic Garden.

To the earlier paper (Jeffers, 1953) the following corrections should be made:—

p. 108, line 18 from the bottom:—For "1698" read "1689"
p. 115, line 29 from the bottom (right-hand column):—For "Pinus Pinaster, L." read "Pinus Pinaster, Soland. in *Ait. Hort. Kew*, **3**, 367 (1789)."
p. 117, line 18 from the bottom (left-hand column):—For "Blitnm" read "Blitum"
p. 122, line 19 from the top (right-hand column):—For "Nigella salivia, L" read "Nigella sativa, L."
p. 128, line 17 from the bottom:—The reference should read "*Arb. et Frut. Brit.* **1**, 50 (1838).
p. 132, line 4 from the bottom (left-hand column):—Against "Liquidambar" insert "128".

Acknowledgments

For assistance during the preparation of this paper I am much indebted to the Staff of The Linnean Society of London and to that of the Westminster Public Libraries, while the Staff of the Guildhall Library in the City of London kindly allowed me to consult the Minute Books of the Society of Apothecaries.

List of Works Consulted.

Ainsworth, J. 1942. *Index to Wills Proved in the Prerogative Court of Canterbury*, **9**, 3.
Elwes, H. J. & Henry, A. 1910. *Trees of Great Britain and Ireland*, **5**, 117.
Gerard, John. 1597. *The Herball*. London, p. 1177.
Hunt, Rev. W. M. 1908. *The Registers of St. Paul's, Covent Garden*, **4**. *Pubs. Harl. Soc.*, **36**, 70.
Hutchins, Rev. John. 1774. *The History and Antiquities of the County of Dorset*, **1**, 384.
Jeffers, R. H. 1953. Edward Morgan and the Westminster Physic Garden. *Proc. Linn. Soc. Lond.*, **164**, 102–133.
Keynes, [Sir] Geoffrey. 1951. *John Ray, A Bibliography*. London, pp. 73–84.
Miller, Philip. 1740. *The Gardener's Dictionary ... Abridg'd from the Folio Edition*, **3**, London, sub. art. *Abies*, **1**.
——. 1750. *The Gardener's Dictionary*, ed. **7**. London, sub. art. *Abies*, **8**.
——. 1768. *The Gardener's Dictionary*, ed. **8**. London, sub. art. *Abies*.
Plukenet, Leonard. 1691. *Phytographia* Pars 1. Londini, t. 1, f. 1.
——. 1696. *Almagestum Botanicum*. Londini, p. 1.
——. 1705. *Amaltheum Botanicum*. Londini, p. 1, Pl. 351, f. 2.
Pritzel, G. A. 1851. *Thes. Lit. Bot.* Lipsiae, p. 240.
——. 1872. *Thes. Lit. Bot.* Ed. 2. Lipsiae, p. 257.
Raven, C. E. 1942. *John Ray, Naturalist: His Life and Work*. Cambridge, pp. 227–242.
Ray, John. 1688. *Historia Plantarum*. London, **2**, 1916.
Ridge, C. H. 1948. *Index to Wills proved in the Prerogative Court of Canterbury*, **10**, 131.
Williamson, G. C. 1934. *Bryan's Dictionary of Painters and Engravers*, **5**, 111.

A LINNAEAN HERBARIUM IN PARIS

By A. H. G. Alston.

It is difficult to know where to begin, but perhaps it is best to relate first the story of how I came upon the herbarium. A few years ago I was in Geneva and asked the botanists at the Conservatoire Botanique if they had a volume of Burman's plants, which could have been the basis of Burman's *Thesaurus Zeylanicus*; that is to say the collections sent by Hartog to Voss and mentioned on p. 370 of vol. 5 of Trimen's *Flora of Ceylon* (1900). I received the reply that Delessert had had a volume of Burman's plants but that under his will his herbarium had been bequeathed to Geneva and his library to the Institut de France. Some volumes of plants had been regarded as part of the library and were therefore in Paris. Last summer I happened to be in Paris and took the opportunity of visiting the Institut de France. Before this could be done I had to secure a letter signed by two members of the Institut. I am greatly indebted to Prof. Humbert and Prof. Heim who signed on my behalf. When I reached the Library I was told that there was no Burman herbarium but on looking through the catalogue I came upon the following entry (on p. 223) :—

> VIII (973) " Plantae Lapponicae ab ipso Linneo collectae " Herbier composé de 379 [trois cents soixante dix neuf] plantes, avec légendes manuscrites.
>
> XVIIIe siècle. Papier 155 feuillets. 400 sur 270 millim. Cartonné.

My curiosity was aroused and I asked to see the volume. The plants were mounted on small sheets but there was extremely little handwriting which could possibly be that of Linnaeus. However, though disappointing, the matter seemed worth further investigation and I arranged for a microfilm to be made and sent to me for further study. The handwriting seemed vaguely familiar and on thinking it over I realized that it was that of J. Burman. This then was the Burman herbarium.

On my return to London I found no mention of the plants in Jackson's *Index to the Linnean Herbarium* (1912), but the volume is described in Lasègue's *Musée Botanique de M. Benjamin Delessert* (1845), p. 66, in the following words :

> " Un petit herbier assez curieux provient également des Burmann : c'est une collection de plantes de la Laponie, récoltées et envoyées par Linné, lui-même, à l'un des Burmann, et dont quelques-unes portent des annotations de la main de Linné, espèce d'herbier-type de la *Flora lapponica* qu'il a publiée en 1737 ".

De Candolle (1845 p. 6). also mentioned the Herbarium

The herbarium was consulted by T. M. Fries who published a full account in Swedish in 1862, with identifications of the specimens, and by the Salicologist Enander in 1910. The Salices have been annotated by Wahlenberg so it is evident that he also saw the herbarium, apparently after 1812, as it is not mentioned in his *Flora Lapponica*. It was also exhibited at a recent Franco-Swedish Exhibition in Paris. However, this herbarium has been entirely overlooked by the majority of botanists and it is for this reason that I am bringing the matter before the Society.

Something of the way in which Burman acquired the collection is revealed in one of J. Burman's letters to Linnaeus, published by H. C. van Hall in 1830, p. 14, dated Amsterdam, 19 November 1738. Burman writes (as translated from Latin into English) : " The plants, which you formerly solemnly promised to me, I shall await and will accept, but I shall be surprised if you are able to

collect them in so short a time from the remote deserts of Lappland". It looks as if Linnaeus had contemplated a second journey to Lapland and as he was unable to carry it out had sent Burman the bulk of the plants collected on his first journey.

The Burman herbarium contains about two-thirds of the species described in the *Flora Lapponica* published in 1737. Most of these (the Salices are an exception) are not duplicated in the Linnean herbarium, which however fills up many of the gaps. It is probable that many more will turn up, as they are usually without labels, and can be recognized only by the small sheets, or, less frequently by the numbers only. Linnaeus wrote a few names on the sheets. He also wrote the numbers of the *Flora Lapponica*. When the collection came into Burman's hands he entered the synonymy fully on each sheet but not always correctly.

Some of the illustrations in the *Flora Lapponica* appear to have been drawn from the specimens (e.g. *Saxifraga cernua*, f. 88, no. 172) but more often they bear only a general resemblance to them. It is evident that Linnaeus made drawings in the field, for example his figure of a Lapp plough, so it is probable that most of the plants were drawn in the field, and subsequently they or duplicate specimens were pressed. Probably the specimens were no longer with Linnaeus when he wrote the *Species Plantarum*, but, as much of that book is copied from his earlier works, many of the specimens we are now considering are probably the types, and I hope that the microfilm, together with an index, which will be available for consultation at the British Museum (Natural History), will be useful to botanists.

References.

Bouteron, M. & Tremblot, J. 1928. *Catalogue Général des Manuscrits des Bibliothèques de France, Paris. Bibliothèque de l'Institut.* Ancien et nouveau fonds. Paris.

De Candolle, Alphonse. 1845. *Sur la "Musée Botanique de M. Benjamin Delessert"*, Bibliothèque universelle de Genève n.s. **57**, 3–32.

Enander, S. J. 1907. *Studier öfver Salices i Linnés Herbarium.* Uppsala.

——. 1910. Ett Linné herbarium i Paris, in *Bot. Not. pp.* 203

Fries, T. M. 1861. Anteckningar rörande en i Paris befintlig Linneansk växtsamling, in *Öfvers. K. Vet. Akad. Förhandl.*, **18**, 255–272.

Hall, H. C. van. 1830. *Epistolae ineditae Caroli Linnaei.* Groningen.

Jackson, B. D. 1912. Index to the Linnean herbarium, in *Proc. Linn. Soc. Lond.*, **124**, Suppl. 1–152.

Lasègue, A. 1848. *Musée Botanique de M. Benjamin Delessert.* Paris.

Linnaeus, C. 1737. *Flora Lapponica.* Amstelaedami.

Savage, S. 1945. *A Catalogue of the Linnaean Herbarium.* London.

Trimen, H. 1900. *Handbook to the Flora of Ceylon.* London.

Wahlenberg, G. 1812. *Flora Lapponica.* Berolini.

THE BIOLOGICAL WORK OF THE FOREST PRODUCTS RESEARCH LABORATORY, PRINCES RISBOROUGH

I. The Work of the Wood Structure Section.

By E. W. J. Phillips, B.Sc., Ph.D., A.R.C.S.

It is a truism that the properties of a material depend ultimately on what it is made of and, broadly speaking, our task in the Wood Structure Section of the Forest Products Research Laboratory is to see of what wood is made, and, particularly, to investigate its anatomical structure. I shall not attempt to give a complete survey of our work but will deal with a few selected aspects which are of general interest in connection with the relations between the structure and properties of timber.

In dealing with these relations it is convenient to consider the anatomical structure as affecting properties through three basic factors :—

1. The amount of wood substance present.
2. The distribution of that wood substance.
3. Its composition.

Each of these factors is subject to considerable variation even within each species, and for that matter, even within a single tree.

1. *The amount of wood substance* is normally assessed by determining the specific gravity or bulk density of the wood. The specific gravity of dry cell wall is about 1·5. The actual bulk density of the seasoned timber depends of course on the proportion of solid cell wall to void air space present. In some species the presence of resin, gum and other extraneous materials will add to the weight of the timber. (*A slide of lignum vitae and balsa in transverse section to illustrate the range of density found in commercial timbers, and the related anatomical differences was shown*).

The density is of technical interest since it directly affects so many of the properties of timber. Nearly all strength properties are related more or less closely to density and so are its woodworking qualities and to some extent its shrinkage characteristics. Density varies a good deal within each kind of timber and the effects of this are usually taken care of in practice as far as strength is concerned by allowing adequate safety factors in designing wooden articles and structures. Sometimes, however, this variation does cause trouble and as an example of one kind of practical problem which is put up to us from time to time I propose to tell you about the recent case of a firm of furniture manufacturers who switched over from using European oak to Japanese oak for their chair legs, and immediately ran into trouble with breakages. We sampled the shipment of timber concerned and confirmed that the trouble was due partly to the lower average density of the Japanese oak and partly to the different character of the density variation in this timber. (*A slide illustrating frequency distributions for density in the two timbers was shown. The Japanese oak is more variable than the European oak in the sense that there are more pieces differing substantially from the average density. In the slide, a line drawn across the two graphs at the minimum safe density, as computed from strength data, showed the marked difference between the two timbers in regard to the risk of encountering timber below the safety limit*). We were able to demonstrate to the firm the basic nature of their problem and to indicate what percentage of breakages they must expect if they continued to use this kind of timber for this particular design of chair leg. This didn't, in itself solve the problem but the firm knew where they stood and could either proceed to weed out the light-weight pieces, change back to using European oak or alter the design of the chair leg. In the event they reverted to European oak.

Variation in density in any species of timber is bound up with inherent density patterns within the tree and superimposed on these are the effects of climatic and other environmental factors. Despite all the work which has been done in the past there is still need for fundamental studies into the causes of density variation and a little work on this line is in progress at the Laboratory.

2. *The distribution of the wood substance.*—There are two broad types of distribution found in the woody dicotyledons. The majority have the vessels more or less uniformly diffused throughout each growth ring : this is the diffuse porous type e.g. poplar ; the majority of temperate timbers and nearly all tropical timbers have this kind of distribution.

In the second type there is a springwood zone of large vessels with relatively poor development of fibres, and a contrasting summerwood zone consisting primarily of fibrous elements : this is the ring porous type e.g. English ash, oak, chestnut and elm.

The type of distribution largely determines the effect of growth rate on density. Thus in timber of the diffuse porous type the width of the growth ring has little effect on density, as would be expected from the uniform distribution of the wood substance. In the ring porous types on the other hand ring width has a marked effect. The ring of large springwood pores seems to be a "must" and is formed regardless of whether the complete ring is wide or narrow. The general result is that slowly-grown wood of the ring porous type is light in weight and often low in strength. There are exceptions to this rule that faster grown wood is heavier and stronger owing to the fact that the quality of the summerwood, as judged by the thickness of the fibre walls, varies a good deal. As far as strength is concerned the thick-walled fibres are more efficient, weight for weight, than thin-walled fibres. Narrow-ringed timber with relatively narrow but dense summerwood is stronger than wider-ringed timber of the same density, having broader summerwood composed of thinner walled fibres.

In softwoods (conifers) we can recognize distribution patterns somewhat comparable with the diffuse-porous and ring-porous types of hardwoods (or dicotyledons). Thus we have the pitch pine or larch type having typically well-defined springwood and summerwood zones differing in density, and spruce and podocarpus, and various cedars and cypresses with a more diffuse type of distribution of the wood substance.

Within both types there is considerable variation in the amount and distribution of the wall substance, but again specimens having dense summerwood are the stronger weight for weight.

To sum up: it is clear that the distribution of the wood substance has an effect on strength independent of density and where we have conditions which encourage the full development of at least some of the fibres so as to give a band of dense summerwood we tend to get a more efficient type of timber than we do if the same amount of cell wall substance is more uniformly diffused.

3. *The composition of the wood substance.*—Several years ago it became clear to us that the amount and distribution of the wood substance were not the only factors controlling the strength of wood. Test specimens matched for density and structure were still found to differ considerably in strength.

My former colleague, S. H. Clarke, followed up the traditional idea that the strengthening constituent of the fibre wall is lignin. He examined the behaviour of thin sections, prepared from the test pieces, with botanical reagents for lignin and cellulose and found that the specimens which were stronger than average for their weight gave a strong lignin reaction whereas the weak specimens gave a poor lignin reaction but stained well with cellulose stains. A variety of stains and reagents were tried but for most of the work safranin followed by fast green was used—the safranin picking out the more lignified elements and the fast green the poorly lignified.

Staining tests were next made on all the timbers for which comparable average strength figures were available and this showed the wide application of the staining reaction as an indicator of strength. Timbers much above the average strength for their weight gave a good lignin reaction and those below the average gave a poor reaction.

This led to the discovery that it was the tropical timbers which were generally more highly lignified, and, weight for weight, they were stronger than those from the temperate zone.

By comparing timber grown in the tropics with the same or allied species grown under temperate conditions it was shown that the degree of lignification depended on where the timber was grown rather than on whether it belonged to a tropical or temperate genus. For example, the common walnut, *Juglans regia*, grown in this country was poorly lignified but that grown in India gave a strong lignin reaction.

I should say at this point that no consistent relationship has been found between the degree of lignification revealed by our botanical stains and the amount of lignin determined by standard chemical analysis. This is perhaps not surprising since chemical lignin is the result obtained from an arbitrary system of analysis rather than a substance of definite chemical constitution.

For the present we will confine ourselves to "botanical" lignin (whatever that may be chemically) since clearly it has special significance as far as the mechanical properties of timber are concerned.

We should naturally like to know the reason for the observed variations in lignification, and better still how to control the variation so that we could discipline trees to produce timber having an optimum degree of lignification.

The study of tropical and temperate timbers points to some climatic factor controlling lignification and recent observations suggest that light may play an important part.

During an investigation on English ash it was noticed that the fibres of the springwood zones are generally poorly lignified. It is known that much of this early growth is produced before the leaf buds have opened. This observation strongly suggested that although leaf activity was not essential for the formation of the new wood fibres, it was essential for their lignification. To test this idea a shoot on which the leaves were only partly developed was covered with an opaque hood for a fortnight. The leaves became etiolated and were given a month of normal exposure to recover, and were then covered up for another 3 weeks until mid-July. After that they were left exposed for the rest of the season.

Sections of the experimental shoot showed that a lignified zone was formed during the first period the leaves were re-exposed to sunlight, but that very little lignification of the fibres occurred during the final exposure to light from mid-July onwards despite the presence of plenty of reserve starch. This is of particular interest since further hooding experiments on various species carried out towards the end of the growing season produced no appreciable effect, the fibres lignifying quite normally. In this case the trees had not been starved of light earlier in the season. It seems significant that in the ring next to the pith, which, of course, represents the terminal shoot, the early growth is quite well lignified. Now this growth is formed only after the apical bud has opened and spread its leaves.

These observations suggest :—

1. That lignification of the fibres is dependent on some "lignin factor" which is normally produced by the leaves,

2. That it takes quite some time during the spring and early summer to produce enough of this factor to bring about normal lignification in the stem.

3. That accumulation of a sufficient quantity of this lignin factor can take place during the summer to carry on lignification if further supplies from the leaves are cut off towards the end of the season.

4. That the lignin factor, although in abundant supply at the end of the season does not keep during the winter, and next spring a fresh quantity has to be built.

Whether this lignin factor is simply a lignin precursor, or something in the nature of a stimulant which triggers off lignin production from local reserve materials has yet to be determined. It is possible that the better lignification found in tropical timbers is due to their more continuous growth, under better and more constant conditions of illumination : as a rule there is no need to start building up a concentration of lignin factor afresh each year.

Some recent work on tropical xerophytes suggests that lack of phosphates

in some tropical soils may play an important part in causing high lignification under conditions of excessive exposure to light. The suggestion is that the lack of phosphate makes it difficult for the plant to convert the abundant photosynthetic products into reserve starch and so they are diverted to excessive lignin production instead. So far I have talked about lignification of the fibres since these are probably the most important elements as far as the strength properties of timber are concerned.

The other elements, the vessels, parenchyma and rays are also of interest. Their lignification normally precedes that of the fibres, and they are nearly always lignified even when the " lignin factor " is in too short supply to allow lignification of the fibres, as may be the case in spring or after hooding. The fibres differ from the other elements in several respects but perhaps most significant in the present connection is the fact that the fibre walls are usually poorly pitted, indicating that very little of the wall area is penetrated by protoplasmic strands while it is being formed. In marked contrast the vessel walls, which almost invariably become well lignified, bear numerous pits and appear to have a better chance of receiving any lignin available, and if the supply is limited none is left for the fibres.

Apart from the normal process of cell wall lignification we have considered certain abnormal conditions in the hope that they might throw light on the nature of the normal process. One of these cases concerns the special type of wood formed on the lower side of leaning stems of conifers known as compression wood. This kind of wood is of particular interest in the present connection since it consists of heavily lignified elements. We decided to try the effect of hooding a conifer stem which had been bent over. Thus, on the one hand, by hooding, we upset what may be the normal lignification mechanism while, on the other hand, by bending the stem, we provided a stimulus for the production of highly lignified tissue. The stem reacted to the dilemma by producing compression wood in the normal way, i.e. lignification can be induced to take place locally, independently of the normal activity of the leafy shoot, if the right stimulus is given. In another experiment a similar stem was girdled above the bent portion and the girdling also failed to stop the formation of compression wood, again indicating local control of the process. It is tempting to suspect some hormone of being at the bottom of this and it certainly seems significant that compression wood can be induced in vertical stems by applying hormone. Under natural conditions local development of compression wood has been caused by sap-sucking insects whose saliva was found to contain a hormone.

From the observations and experiments made so far, it seems fair to sum up by saying that the production of the stuff we botanists regard as lignin, is a delicately balanced process which may be disturbed in a number of ways ; and we have reason to believe that light and the orientation of the stem are two important factors affecting the process.

Soil phosphate also seems to be a possible factor ; and under certain conditions at least a hormone may be involved. In species of the temperate zones there is also a seasonal factor demanding further study.

There is reason to hope that further investigations into these putative factors on the anatomical side in conjunction with physiological and microchemical work using new tracer and chromatogram techniques can give us a more precise insight into the mechanism of lignification and the factors controlling it. Once we have this we may be better able to make a positive attack on the problem of controlling not only the amount and distribution of wood substance produced by the tree each season (which we can do to a certain extent already) but also of controlling its composition, and in this way provide timber of optimum quality.

II. The Work of the Mycology Section.

By J. G. Savory, B.Sc.

For convenience, the timber fungi can be considered as belonging to four main groups :—

1. The wood-destroying Basidiomycetes, which more than any others limit the uses for which timber can be employed.
2. The blue stain or sap-stain fungi, micro-fungi which grow chiefly in the sapwood of felled timber causing discoloration but not decay.
3. The wood-rotting micro-fungi or "soft rot" fungi: a group in which interest is of comparatively recent origin.
4. The harmless surface moulds—"harmless" because they do not decay or markedly discolour the wood.

The wood-destroying Basidiomycetes are of the greatest economic importance and correspondingly much time has been devoted to study of them. With a few exceptions, it is not easy by examining a piece of decayed wood to name the Basidiomycete which has caused the decay. The fungus can usually be isolated from the decayed wood and grown in culture but Basidiomycetes do not fruit easily in culture. Thus, to aid identifications, the first of the long-term projects upon which the mycology section embarked when the laboratory was founded was the development of a collection of named Basidiomycetes growing in pure culture. This collection now contains some 500 strains and it has become the national type culture collection of wood-destroying Basidiomycetes.

General testing work.—The laboratory as a whole investigates the properties of new and unfamiliar timbers when they come on to the market. The role of the Mycology Section is to assay the natural resistance of the timber to fungal attack. This is done by determining the amount of weight lost when samples of the wood are exposed to attack by Basidiomycetes in pure culture. The value of this test is that the resistance of timbers can be determined in a few months whereas field trials require many years. The test has been used recently to show that the decay resistance of African mahogany may vary widely from the outer to the central heartwood—the central heartwood in some trees having little resistance to decay.

Another task is the laboratory testing of the toxicity of chemicals and of proprietary wood preservatives. The ultimate aim is to improve the quality both of the materials offered over the counter for home use as dry rot preventatives and also the materials employed by large industrial concerns which use elaborate plants and impregnate timber with preservatives under pressure. The test method is similar to that used for determining the natural resistance of timber except that standard species of timber are impregnated with a series of dilutions of the material under test and are then exposed to fungal attack. We are aware that the test employed is of limited value in assessing the ultimate worth of a chemical as a wood preservative and we have continually studied the test method in order to effect improvements. Over the past few years we have carried out a series of tests by the American method, using wood strips over soil as a medium for growing the fungi instead of agar and we have just completed a co-operative test with other laboratories in this country to determine the extent of variation in test results. The outcome has provided a salutary reminder of the variability of biological testing. The greatest variation in results occurred, not when different soils were used, but when the tests were carried out by different laboratories!

Recent research work.—We have shown that some fungi are xerophytic when growing in timber and can survive for many years in pieces of wood kept under dry conditions. The strongest xerophytes, such as *Lenzites trabea* ([Pers.] Fr.) Fr., survive longest when kept under *very* dry conditions. On the other hand, the true dry rot fungus, *Merulius lacrymans* [Wulf.] Fr., survives for barely six months under really dry conditions.

Experiments on eradication of *Merulius lacrymans* from infected masonry indicate that in contact with lime, which is always present in masonry, sodium fluoride and magnesium silico-fluoride, both widely used as fungicides on infected masonry in the past, are ineffective. Copper sulphate is also ineffective, a result which is very surprising in view of the association of copper sulphate with lime in Bordeaux mixture. On the other hand, sodium o-phenyl-phenate and sodium pentachlorophenate are both highly effective; so too are a number of proprietary preparations.

Sometimes the distribution of decay in buildings leads to the thought that fungus can detect wood from a distance and grow towards it. No directional effect has been demonstrated in the laboratory but we have been able to show that *Coniophora cerebella* Pers. (*C. puteana* (Schum. ex. Fr.) Karst.) grows with increased vigour when small pieces of wood kept well out of contact with the growing culture are enclosed in the culture vessels.

Stimulation of decay of wood in the presence of food materials is quite well known; also we are quite accustomed to noting increased decay in test samples treated with non-toxic concentrations of phenolic preservatives. This occurs most markedly when the fungus is of the white rot type, that is to say it possesses a phenol oxidase enzyme complex. But we have also found recently that decay by *Coniophora cerebella* is markedly stimulated by the presence of small amounts of sodium fluoride. Measurable stimulation occurs when the amount of fluoride present in the wood is too small to detect by chemical analysis and the rate of decay is almost doubled in wood impregnated with a 0·02 per cent solution of sodium fluoride.

Timber shortages during and after the war led to the importation of a large number of "new" tropical hardwoods of low resistance to fungal attack. Some in fact have become quite well established on the market but because of their low resistance all suffer a tendency to develop fungal stains. We have found that most of the stains in these hardwoods, irrespective of timber species or country of origin, are caused by *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl. or, to a lesser extent, *Diplodia natalensis* Pole Evans. As occasion offers we are studying the behaviour of these fungi in the wood and it is becoming clear that they are more resistant than the common staining fungi of temperate softwoods (*Ceratocystis* spp.) to the chemicals normally used for preventing stain in timber.

One of the most important aspects of our work since the war has been that relating to the recognition of micro-fungi—Fungi Imperfecti and the smaller Ascomycetes—as wood-destroying organisms of economic importance. We suspect that they cause much of the ultimate decay of the most resistant hardwoods and that they have often been the cause of failure of preservative-treated telegraph poles and fence posts. In this country they are the basic cause of failure of the timber slats over which the hot water flows in the water-cooling towers used in many industrial plants and we know of a number of other situations such as boats, vats, draining boards, dyeworks and laundry trucks and in exposed plywood, where they also cause timber failures.

Any piece of wood submerged in fresh water for a few years becomes softened and discoloured on the surface. When the wood is removed from the water and dried the surface hardens again and cracks quite characteristically;

if the wood is now cut across with a saw a sound central core is found surrounded by a thin outer zone of decayed wood.

The distribution of the fungal hyphae in attacked wood is both interesting and significant. It is best appreciated in contrast with the appearance of blue stain fungi and Basidiomycetes in the wood. The blue stain fungus with dark-coloured hyphae lies in the lumen of the wood element and passes through the wall by way of a penetration that may be too fine to see clearly under the microscope. The wood-destroying Basidiomycete also lies within the cell cavity and its hyphae occasionally pass through the walls by way of bore holes which, though small at first, may become enlarged by enzyme activity until they may be many times larger than the hypha which gave rise to them.

Soft rot is perhaps best observed in transverse sections, for the fungal hyphae lie *within* the thickness of the wood cell walls. They are restricted to the central layer of the secondary wall—the least heavily lignified layer composed chiefly of cellulose. Cavities develop in the wall around the hyphae, and, in the later stages of attack, the central layer of the wall may be almost entirely destroyed. In longitudinal section the appearance of the wood is again strikingly characteristic. The hyphae within the cell walls pursue a course which is believed to correspond with the direction of orientation of the cellulose micellae—usually an open spiral. Ideal conditions for observing the cavities are obtained if very thin sections are examined under polarized light, when it can be seen that each hypha lies within a cavity which has a characteristically pointed end. In thick-walled elements, chains of cavities with pointed ends are often found.

About a dozen species of fungi have been proved capable of causing soft rot. Members of the genus *Chaetomium* predominate in this list but it is suspected that many other strongly cellulolytic types will also attack wood. However, so far almost all of our laboratory work has been carried out with *Chaetomium globosum* Kunz ex Fr.

Throughout the course of decay experiments with this fungus in the laboratory, the density of perithecium formation has served as a criterion of the extent of decay. Fruiting bodies are rarely found on naturally decayed timber yet the frequency with which *Chaetomium globosum* has been isolated from naturally decayed wood has given rise to the belief that it must be a widely distributed soft rot fungus and it seems probable that the amounts of nutrient available to the fungus under natural conditions are insufficient to encourage extensive formation of fruit bodies.

Under laboratory conditions we have shown that decay of hardwoods by *Chaetomium globosum* follows much the same pattern as their decay by Basidiomycetes. That is to say that the hardwoods which are readily decayed by Basidiomycetes are readily attacked by *Chaetomium* and those resistant to Basidomycete attack are also resistant to *Chaetomium*. The softwoods show a marked contrast; none of those tested has been readily or reproducibly attacked by *Chaetomium* and this includes the sapwood of Scots pine and spruce, neither of which shows any resistance to attack by Basidiomycetes. There is a higher proportion of lignin in softwoods than in hardwoods and this may be the cause of their greater resistance to *Chaetomium*.

Laboratory experiments to determine the nutritional requirements of *Chaetomium globosum*, and its physical and chemical effects on the wood, are in progress. The fungus attacks chiefly the non-lignified components of the wood and the extent of attack is markedly dependent upon the amounts of inorganic salts, chiefly nitrates and phosphates, which are available.

Thus we have already reached the conclusion that the wood-rotting microfungi differ markedly from the wood-destroying Basidiomycetes both in their mode of attack of the wood and also in their nutritional requirements.

III. The Work of the Entomology Section with Particular Reference to the Common Furniture Beetle, *Anobium punctatum* Deg.

By J. D. Bletchly, B.A., B.Sc., F.R.E.S.

The Entomology Section is concerned with the defects caused by insects in timber in all its stages. Under natural conditions wood-boring insects perform a useful task in assisting in the reduction of wood to humus and there is an ecological succession of different groups; the ambrosia (pinhole borer) beetles and wood-wasps attack newly-felled and in some instances standing trees, longhorn beetles newly-felled timber, powder-post beetles partially and fully dried timber, furniture beetles seasoned wood (sound or decayed), wood-boring weevils very damp or partially decayed wood, and in addition there are a variety of insects which inhabit heavily rotted wood.

The economic losses caused by wood-boring insects are greater than is generally realized. In order to check or prevent these losses, it is necessary to ascertain which groups of insects are concerned. Investigations may be conducted under the following headings: surveys of the problem, research on the biology of the insects and their rates of development, the species and condition of timber subject to attack, the nutritional requirements of the insects and the factors affecting their activity and spread, the methods of preventing and controlling attacks, and, finally, the application of these results to industrial and public purposes in the shape of advisory work comprising inspections, correspondence and publications of a popular nature.

The Entomology Section has been in existence for nearly 30 years and during this period the emphasis on different aspects of the economic problems has shifted. Before the Second World War most attention was given to the insect pests of imported American hardwoods (mainly *Lyctus* powder-post beetles) and to those attacking the hardwoods of our ancient buildings (chiefly the death-watch beetle). Now improved control methods and changes in ways of handling, and in the types of hardwoods used, have reduced the significance of the powder-post beetle problem; again better understanding of the significance of the association between death-watch beetle attack and conditions of dampness and fungal decay as a result of the researches of Dr. R. C. Fisher, the Officer in Charge of the Entomology Section, has led to improved methods of restoration (Fisher, 1941). In consequence of the recent increased use of tropical hardwoods ambrosia beetle damage has become a major problem and a special Unit—the West African Timber Borer Research Unit—was set up by the Colonial Office in 1952 to investigate the biology of these insects with special reference to their associated fungi, and to develop methods of control. The work of the Unit is under the general supervision of the Officer in Charge of the Entomology Section and is being carried on in close collaboration with the entomology and mycology sections of the Laboratory, where one member of the Unit is at present stationed.

Another problem which has become more important in recent years concerns infestation by the house longhorn beetle (*Hylotrupes bajulus* L) chiefly confined to certain areas of Surrey.

Research on present-day problems arising out of infestation by these wood-boring insects is in progress at Princes Risborough but time does not permit of an account of the whole of such work and its results. It is proposed, however, to describe some current investigations on what is probably the best known wood-boring insect in this country—the common furniture beetle—*Anobium punctatum* Deg., the most frequent cause of woodworm damage in timber and furniture.

The common furniture beetle is found in many of the temperate zones of the world and is widespread in our country. It is generally considered that

attacks are most severe in the west country, the western part of Scotland, Ireland and places with damp climates. The sapwood of both hardwoods and softwoods is attacked and the cheaper grades of plywood made up with blood-casein glues and wicker work appear particularly suitable. As yet there is no information regarding the susceptibility of tropical hardwoods, now very widely used. There appears to be an increase in the extent of infestation, probably due partly to the use of greater quantities of poor quality quick-grown softwood with wide sapwood, to the extensive use of cheap plywood of the type already mentioned as well as to war conditions such as bomb damage, lack of maintenance and repairs, shortage of fuel and consequent greater dampness and to storage of furniture over long periods. Although this pest does not often inflict major structural weaknesses yet, judging from advisory work, the number of enquiries in which this insect is involved far exceeds all others in this country. The research programme on this insect, commenced before but suspended during the war has, therefore, been intensified. The name " common furniture beetle " is something of a misnomer as an analysis of 602 advisory enquiries concerning this insect received during the course of a recent year shows: —structural timbers 56 per cent, furniture 19 per cent, other woodwork and plywood 25 per cent. It is probably not generally realized that this insect commonly occurs out-of-doors not only in out-buildings but also in old fences, dead parts of trees and hedges, and similar situations.

Since feeding and resultant damage occur only during the larval stage—the longest part of the life cycle—research has been concentrated on this stage. In Germany, investigations have been conducted mainly by transferring larvae of known weight from infested wood into experimental blocks, a method yielding relatively quick results but suffering from various limitations, in particular that data are only obtained on one part of one stage of the life cycle. It was, therefore, decided to undertake our investigations by obtaining normal infestations through egg-laying. Eggs are usually laid in cracks and crevices and in old flight holes and a technique has been developed (a modification of a New Zealand method where this insect has also been studied (Kelsey, 1947)) of providing a suitable and standardized surface by mechanically securing butter muslin over the end grain (Bletchly, 1952).

Anobium successfully completes its life cycle in sound wood but it has been noticed that attack often appears more severe in decayed wood. Investigations in progress on the effect of fungal decay on the suitability of wood for attack have so far shown that in the case of beech and oak sapwood, decayed by *Polystictus versicolor* (L) Fr. to varying losses in weight, accelerated the rate of larval development to an extent increasing with the degree of loss in weight of the wood. Fungal decay also facilitated the establishment of larvae (Bletchly, 1953*a*). Although heartwood is normally immune from attack in those timbers where it can be distinguished from the sapwood, yet in the presence of fungal damage, heartwood may be attacked or even preferred to the sapwood, thus increasing the significance of *Anobium* as a structural pest. The explanation of the effect of wood-destroying fungi is not fully understood but has been reviewed in the case of the related death-watch beetle by Fisher (1952) ; it is possible that fungi increase the content of something of nutritive value, for example nitrogen, or else that by weakening the wood they facilitate larval boring and feeding, or possibly the effect may be due to a combination of factors. It is of interest to note that one sample of Scots pine heartwood attacked by this insect and examined in the course of advisory work was found to contain fungi of a non wood-destroying type which may be held to support the view that fungi add something of value or perhaps remove a toxic substance rather than produce a softening effect.

It was found that in walnut the presence of soft rot facilitated initial larval

penetration, but little is known of its effect on the suitability of wood for the development of the common furniture beetle and an experiment is at present being planned to investigate this matter.

The cheaper grades of plywood of the birch-alder type made up with blood-casein glue are very frequently attacked and laboratory studies have confirmed that the presence of this glue in birch plywood accelerated larval growth. However, where urea formaldehyde was used in similar material made up from veneers infestation died out at a very early stage. This unsuitability of plywood with urea formaldehyde and its avoidance by females for egg-laying probably explains the absence of records of attack by this insect in plywood made up with synthetic glues. It is interesting to note, however, that plywood made from hardwoods susceptible to *Lyctus* and urea formaldehyde adhesives, is not immune from attack by *Lyctus* powder-post beetles.

Before the factors which govern the suitability of wood for infestation and larval development can be understood, it is necessary to know the nutritional requirements of the larvae and this problem is being investigated by several methods. Earlier work in Germany (Becker, 1942) showed that certain zones of sapwood may be more suitable than others. Our experiments with two softwood timbers (Corsican and Scots pines) have confirmed this. In these timbers suitability decreases towards the inner sapwood : concomitant chemical studies have revealed a decreasing gradient in nitrogen content from the periphery inwards and this may be the explanation : on the other hand toxic substances might be present in the inner sapwood. (Erdtman (1952) in Sweden has shown the presence of such substances (pinosylvins) in pine heartwood.) Becker (1942) obtained similar results when examining the zones of Scots pine sapwood. Studies of birch, a " sapwood " timber having no clear distinction between sapwood and heartwood, have shown that there is no marked variation in the suitability of the wood across the outer 5 in. of logs of a radius between 7 in. and 9 in. Whether the zones examined are all physiological sapwood seems doubtful. No chemical data are available on nitrogen contents. This absence of a gradation in suitability is probably contributory (in addition to the presence of blood and animal glues) to the high degree of susceptibility of birch plywood. The presence or absence of zoning effects across the sapwood in different species of timber must clearly be borne in mind in planning future experiments and in the selection of material for preservative testing.

Nutritional requirements have also been studied by exhaustive extraction of wood blocks with different solvents. Pre-treatment with water at 60° C. reduced the suitability for subsequent larval development of both Corsican pine and oak sapwood and with a boiling treatment at 100° C. few larvae survived in the former and none in the latter timber. At these temperatures water is likely not only to extract cell contents but also to hydrolyse some wood components and to cause some delignification (revealed by microscopic examination in the case of Corsican pine extracted at 100° C.) but also to produce other changes whose cause is unknown, such as darkening of the wood ; in addition, although little nitrogen is extracted, some compounds of it might be converted into less suitable forms. It was, therefore, decided to carry out further work with Scots pine sapwood extracted with water at only 30° C., a temperature at which it was thought that little chemical change in the wood substance would be produced other than extraction of cell contents. This has shown that the suitability of wood for larval growth was greatly reduced, the average weight of larvae 21 months old being only one-fifth of that in the unextracted controls. Although the nature of the chemicals removed is unknown they probably comprise in addition to cell contents, small amounts of soluble components of the cell wall and negligible nitrogen. It seems that cell contents are of importance in the larval diet.

The effect of acetone extraction is somewhat complex :—in Corsican pine sapwood it had little effect but in the sapwood of Scots pine larvae gained weight more rapidly in the extracted material than in the controls. The percentage resin content in the Scots was slightly higher than in the Corsican sapwood, but whether a relatively greater reduction in resin content resulted from extraction of the Scots material with acetone and accounted for this difference in the rate of larval growth, is somewhat problematic. Oak sapwood extracted with acetone was rendered more suitable doubtless due to reduction of the tannin content. Extraction of oak sapwood with ether had little effect. Normally oak heartwood is immune from attack and an attempt to render it suitable by extraction with acetone, ether or water at 60° C. or 100° C. proved unsuccessful.

Nutrition has also been studied by the addition of chemical substances to wood ; so far little work has been carried out on this method but larvae transferred into decayed Turkey oak sapwood impregnated with peptone or yeast were found to gain weight much more rapidly than in the untreated decayed controls, whereas the addition of glucose had little effect.

Another method of investigation has been the preparation of artificial blocks made up from sapwood flour of oak and Scots pine, sometimes with a nutrient additive and bound together with an adhesive (blood, bone, casein or hide glues). Such a material bears no resemblance to the physical structure of wood and the presence of an adhesive forms a further chemical complication. Nevertheless, some success has been achieved by rearing *Anobium* in some of these blocks.

Studies have also been made of the general life history. Data have been obtained on the dates of emergence and mating habits. It has been found that beetles prefer to emerge towards the light rather than the dark, that they re-enter exit holes after emergence and may lay eggs in these holes. It has been found that the females exercise choice in selecting sites for egg-laying ; for example birch plywood made up with urea formaldehyde glue is avoided in the presence of matched material made up with blood or blood-casein glue and solid wood controls. Under household conditions most eggs are laid in the middle part of the day ; few eggs are laid compared with some other wood-boring insects but percentage fertility is high. Under incubator conditions of 22° C. and 86 per cent relative humidity the incubation period varies from 2–2½ weeks, under laboratory conditions from 3–4, and out-of-doors from 4½–5½ and appears to be governed largely by temperature. Rise in relative humidity above about 56 per cent exercises little influence on the length of the incubation period or viability of the eggs, but drier conditions become progressively less suitable and below 40 per cent r.h. few eggs hatch. The rate of larval development is governed not only by nutritional factors, some of which have already been discussed, but also by temperature and humidity and larvae grow much more rapidly at 22° C. and 86 per cent r.h. than out-of-doors. Under such controlled incubator conditions larvae continue to grow to exceptionally large sizes but rarely pupate and complete the life cycle. A diapause appears to be necessary and some success has been achieved in obtaining emergence by exposing wood blocks, containing fully-grown larvae reared under incubator conditions, to low temperature for a time and then subjecting them to normal room or out-of-door conditions, and also by simply transferring such blocks direct from incubator to out-of-door conditions in the winter months. The pupal stage occupies about 8 weeks out-of-doors and the distinctive sex characters which appear at this stage have been described (Bletchly, 1953*b*).

Data are gradually being accumulated on the length of the life cycle and although the literature quotes periods of 1–2 years, it seems more likely that in the U.K. it may be longer and that 3 or more years, at any rate out-of-doors, is more normal. There is little doubt that under unfavourable conditions it

may be longer. Statements are made from time to time indicating that wood is not attacked by this insect until it has been in service for many years and sometimes definite periods are given, such as 10 or more years. By this is apparently meant the appearance of obvious damage in the form of exit holes indicating the completion of the life cycle of at least one generation. If the length of time taken in completing the life cycle is deducted from this "ageing period" of wood and furthermore if it is remembered that since only comparatively few eggs are laid it might take more than one generation to build up an infestation which attracted the attention of the occupant of a house, then it seems likely that attack may commence much sooner after wood has been put into service than has been considered to be the case hitherto. All recent experiments have been conducted with freshly seasoned wood and these have shown that satisfactory development can readily be obtained in such material.

Knowledge of the biology and food requirements of the insect form an essential basis for appropriate and efficient preventive and control measures which are amongst the main objects of applied research of this nature. An insect such as the common furniture beetle which has a long life cycle, lays few eggs compared with other wood-boring insects and will only rarely pupate under controlled conditions of temperature and humidity, constitutes a difficult subject for research. This situation is an unfortunate one since the species is the one most desirable to utilize for the testing of wood preservatives in view of its common occurrence. The fact that this insect has apparently multiplied during and since the Second World War under the conditions prevailing in our homes, but is difficult to handle in the laboratory, is a measure of the incompleteness of our knowledge of its optimum requirements and of the absence of adequate control. This in turn raises the question whether present methods of control could not be improved when more biological data are available.

Acknowledgments.

The author wishes to thank Dr. R. C. Fisher for helpful criticism of this manuscript and for supervision of the investigations and also Mrs. S. Levitt and Mr. B. Goodson for technical assistance.

References.

Becker, G. 1942. Ökologische und Physiologische Untersuchungen über die Holzzerstorenden Larven von *Anobium punctatum*. *Z. Morph. Ökol. Tiere*, **39**, 98–152.

Bletchly, J. D. 1952. A summary of some recent work on the factors affecting egg-laying and hatching in *Anobium punctatum*. (Coleoptera–Anobiidae). *Trans. Ninth Int. Congr. Ent.*, **11**, 728–734.

——. 1953*a*. The influence of decay in timber on susceptibility to attack by the common furniture beetle, *Anobium punctatum*. *Ann. appl. Biol.*, **40** (1), 218–221.

——. 1953*b* A note on the prepupal stage and the external sex characters of the pupae of *Anobium punctatum* (Coleoptera, Anobiidae). *Bull. ent. Res.*, **43** (4), 587–590.

Erdtman, H. 1952, in *Wood Chemistry*, edited by Wise L. E. and Jahn E. C. Ed. 2 New York pp. 661–688.

Fisher R. C. 1941. Studies of the biology of the death-watch beetle *Xestobium rufovillosum*. IV. The effect of type and extent of fungal decay in timber upon the rate of development of the insect. *Ann. appl. Biol.*, **28**, 244–260.

——. 1952. Some aspects of the biology of timber insects. *Science Progress*, **40** (158) 213–232.

Kelsey, J. M. 1947. A note on rearing *Anobium punctatum*. *N.Z. J. Sci. Tech.* B, **27**, 329–335.

NOTES ON THE CRUSTACEAN PLANKTON OF LAKE VICTORIA

By J. Rzoska.

Hydrobiological Research Unit, University of Khartoum.

Lake Victoria forms the head waters of the White Nile and its plankton flows continuously down the river on its northern course. There is some evidence that most of this plankton is destroyed in passing through the rapids and waterfalls of the Jinja stretch and strained by the swamps of Lake Kioga and those on the Albert Nile. Yet it seems likely that traces of it in the form of survivors and resting stages (e.g. ephyppia) may travel unharmed the 700 km. to the entry into the Sudan plains and may contribute to the slow build up of a pure plankton association further downstream. In view of this a knowledge of the zooplankton of Lake Victoria is of considerable interest to the Hydrobiological Research Unit of the University of Khartoum, which endeavours to study the hydrobiology of the Nile system (*Annual Reports*, 1954–56).

A brief survey was carried out in April 1956 with the assistance of the Director and the staff of the East African Fisheries Research Organization at Jinja, Uganda, which is gratefully acknowledged. The present contribution contains a re-examination of existing, mostly outdated sources, and an attempt to establish an adequate basis for more detailed work in the future.

1. History of Investigations.

Thirty years after the discovery of Lake Victoria by Speke (3 August 1858) Emin Pasha and F. Stuhlmann collected the first plankton samples in the lake. Stuhlmann published two interim reports on his activities (1888, 1889) and a short note on the plankton of the " South Creek ", probably the Mwanza Bay (1891). W. Weltner gave an account of the Cladocera of Stuhlmann's material (1897) and later (1898) followed up with a list of Cladocera from Central Africa and the Nile valley. A. Mrazek (1897–98) dealt with the Copepods of Stuhlmann's collections. The next contribution came from E. v. Daday (1907) who discussed the zooplankton of Lake Victoria, on the basis of material collected by A. Borgert in 1904–05 during an expedition supported by the Berlin Academy. In the same year Daday published also observations on the post-embryonic development of *Caridina wyckii* (*C. nilotica*) which occurs in the Lake Victoria plankton. At the same time as Borgert, A. Cunnington collected during his third Tanganyika expedition a few samples from Lake Victoria and G. O. Sars examined critically the Copepods and Ostracods of this collection (1909). A year later, Daday (1910) published a large paper on East African " Microfauna " which contained a list of all invertebrate groups from Lake Victoria.

Six samples from the lake were collected by a Russian expedition led by Dogiel and Sokolow in 1914 and G. Verestchagin (1915) described the fauna. One plankton sample from the lake near Bukoba served Th. Delachaux (1917) as material for his note on the Cladocera. Short references to the taxonomy of Copepods in Lake Victoria are contained in a paper by Gurney (1928). Some recent remarks can be found in the reports of the Jinja Station. E. B. Worthington (1931) studied vertical migration of the Crustacea of the zooplankton ; this is the only paper on general problems.

This ends the list of accessible, published material on the subject. The results furnish a faunistic list which requires revision ; such a short revision is brought together in tabular form showing the gradual establishment of a faunal list of the Crustacea of Lake Victoria plankton. Only truly pelagic forms are included in this table ; some of the earlier authors have also mentioned species

which certainly do not live in the plankton. The taxonomy of freshwater Entomostraca is, to say the least, in a state of indecision. It has been based almost entirely on external morphological details, yet it is well known that e.g. some Cladocera change their external appearance with their physiological breeding cycle. H. Gautier (1954) has shown this recently in his study on *Moina*. In the Copepods many new species have been described outside Europe and Lindberg (1951) has given an impressive synoptic table of African Cyclopids. Yet morphometric-statistical methods as used on some groups of Cyclopids years ago by Kozminski and by Rzoska have not been applied generally because of the time involved. G. Fryer has shown (1956, in typescript) that there exists a clear ecological differentiation in Cyclopids studied by him as to food choice ; mode of life, e.g. pelagic or non-pelagic, should also be taken into account while attempting taxonomic differentiation.

The plankton of Lake Victoria contains species known as European, but nobody has made a thorough examination of their finer morphology and their physiological and ecological status which together only could decide on their identity with European forms.

2. Remarks on the Particular Species.

The above remarks apply to the species commented upon below. Glossaries to the species are compiled from the various authors dealing with Lake Victoria plankton with additions by the author where it was possible.

Diaphanosoma excisum Sars, first mentioned from the lake by Weltner (1897) with remarks on some morphological details ; Ekman (1903) found this species in the Nile Valley, but the temperate *D. brachiurum* was found in Egypt by Richard (1895). There are indications of great morphological variability in the vast circum-tropical area of distribution. This species is a very important constituent of Nile plankton as revealed by sampling over a wide area.

Ceriodaphnia cornuta Sars and *C. rigaudi* Richard. The controversy on the validity of the two forms has lasted for more than half a century, but recently their separation into two species is not any more supported. Rzóska (in press) has shown the instability of the morphological characters regarded as distinctive, the existence of transitional forms and the change of form with the passage of time within one colony. This species should in accordance with priority rules be called in future *C. cornuta* Sars, although the name does not fit the unhorned phase. This species is a tropical cosmopolitan ; the causes of variability and their trend should prove interesting. The species is an important constituent of open lake plankton in Lake Victoria.

Ceriodaphnia dubia Richard was noted by Daday (1910) as frequent in the lake plankton ; Delachaux records this species (probably) as *C. reticulata* var. *dubia* and makes remarks to it. This is a less consistent constituent of Lake Victoria plankton than the previous species ; widely distributed in the tropics but almost nothing is known about its differentiation or ecology.

Other forms of *Ceriodaphnia* have been mentioned for the lake ; Weltner (1897) lists a *Ceriodaphnia* sp., already noted by Stuhlmann, which is impossible to identify. Verestchagin recorded in his very limited material *C. laticaudata* P.E.M. and *C. quadrangula* var. *hamata* Sars which cannot be confirmed.

Moina dubia de Guerne & Richard has been recorded under various names as an important constituent of Lake Victoria plankton. H. Gautier (1954) has given an admirable analysis of some African *Moina* and it emerges that the morphology of this species depends upon environmental conditions and its physiology ; in spite of its variability there are according to Gautier only two definable subspecies of *M. dubia* in his African material : *M. dubia dubia* and *dubia pectinata*, of which the former is widespread in the plankton of African waters and the other confined at present to Madagascar.

TABLE I.—List of plankton Crustacea of Lake

(Rzoska 1956 is tabulated first as it

Species	Rzoska, 1956 (9 stations)	Stuhlmann, 1891 (Mwanza Bay)	Weltner, 1897/98 (4 stations)	Mrazek, 1897
Diaphanosoma excisum Sars	+	—	+	—
Ceriodaphnia cornuta Sars	+	?	C. sp. +	—
C. dubia Rich.	+	—	—	—
Moina dubia G. & R.	+	sp. (*brachiata* ?)	+ *micrura*	—
Daphnia longispina Leyd.	+	sp.	+	—
D. lumholtzi Sars	+	—	—	—
D. barbata (Weltner)	—	—	*jardinei* var. *barbata*	—
Chydorus sphaericus O.F.M.	+	—	—	—
Bosmina longirostris O.F.M.	+	sp.	*stuhlmanni*	—
Simosa vetulus (O.F.M.)	+	—	*capensis* Sars	—
Tropocyclops confinis Kiefer	+	—	—	*prasinus*
Mesocyclops leuckarti Cls.	+	—	—	+
Thermocyclops neglectus (Sars)	+	—	—	*C. oithonoides* Sars
T. schuurmanae (Kiefer)	+	—	—	sp. ?
T. emini (Mrazek)	+	—	—	+
Diaptomus galeboides Sars	+	sp.	—	*D. galebi*
D. stuhlmanni Mrazek	+	—	—	+

Obviously non-planktonic forms mentioned

The following have been named from Lake Victoria : *M. brachiata* O.F.M. by Stuhlmann from the Mwanza region ; Weltner who had Stuhlmann's material did not confirm this find, Daday (1910) regards it as erroneous identification. *M. micrura* Kurz was named by Weltner (1897) from a sample near Djuma Island *M. hartwigi* was found by Verestchagin in the plankton and he expresses surprise because this *Moina* is a littoral and pond form in temperate regions. Other authors note correctly that the Lake Victoria *Moina* is *M. dubia* ; Delachaux gives some morphological details.

Moina dubia is an important species in the lake ; its ecology and physiology should be of great interest.

Bosmina longirostris O.F.M. has been recorded from the lake by various authors, sometimes under names of varieties whose value is not recognized adequately. Distributed all over the world this species is very variable and some varieties have been established without however a thorough critical analysis. Weltner (1897) has described a *B. stuhlmanni* n.sp. from Lake Victoria, which Daday (1910) regards as synonymous with *B. longirostris* O.F.M. var. *similis* Lillj. ; Daday names (1910) *B. l. cornuta* and *B. l. longirostris* as not occurring in the plankton of Lake Victoria. Delachaux,

Victoria in the papers of various authors.

contains the most recent taxonomy.)

Daday, 1907–10 (several samples)	Sars, 1909 (few samples)	Verestchagin, 1915 (6 samples)	Delachaux, 1917 (1 sample)	Gurney, 1928	Worthington, 1931 (one station, many samples)
+	—	+	+	—	+
+	—	+	+	—	sp.
rigaudi		*rigaudi*	*rigaudi*	—	
+	—	*C. quadrangula* var. *hamata*	*C. reticulata* var. *dubia*	—	—
		C. laticaudata			
+	—	*hartwigi*	+	—	—
micrura					
+	—	—	*longispina* var. *hyalina*	—	+
+	—	—	—	—	+
—	—	—	—	—	—
+	—	+	+	—	—
var. *similis*	—	var. *similis*	var. *cornuta*	—	+
		var. *cornuta* Sars	(Jurine)		
+	—	—	—	—	+
+	—	—	—	—	—
+	+	—	—	—	—
sp.	+	—	—	—	sp.
oithonoides Schmeil					
—	—	—	—	—	—
+	+	—	—	—	—
galebi	+	—	—	+	+
small var.	small var.				
+	+	—	—	+	—

by some authors are not included.

however, records *B. l. cornuta* Jurine as *the* plankton form from the lake, and thinks that Daday's var. *similis* may be a seasonal variation. At present the problem of racial differentiation remains still unsettled and only a prolonged observation of the variability including seasonal changes can contribute substantially. This is a consistent component in Lake Victoria plankton.

Chydorus sphaericus O.F.M. is a world-wide distributed species again with morphological variability; Daday (1907 and 1910) and Delachaux remarked on differences between European and Lake Victoria specimens. Fairly numerous in the plankton.

Daphnia longispina Leyd, has been seen already by Weltner (1897) in the lake and differences from "typical" forms were mentioned. Delachaux names his specimens *D. l.* var. *hyalina*; other authors do not mention any variety. Worthington stresses the lack of long spines and helmets and also the lack of epphippial females; however, the problem of racial and physiological differentiation requires larger material and at least a year's observation; it is not true that sexual processes in the Cladocera are rare in the tropics. Woltereck (1930) has contributed to the geographical and racial differentiation of the Daphnias but many problems are still open.

Daphnia lumholtzi Sars lives in the plankton but its occurrence is not consistent in time nor space. Daday found only this species and not the following one, and Weltner has only seen the *barbata* species. The distribution is mainly in the Middle East, the eastern Mediterranean and southern Russia ; in the Nile valley this species advances deeply into Africa.

Daphnia barbata (Weltner) was first described from Lake Victoria by Weltner in 1897 under the name *D. jardinei* Baird nov. var. *barbata* and he recorded also epphippial females and males. Later its independence and validity as species was recognized ; it seems to be a predominantly African species, which descends down the Nile towards the north.

Simosa (*Simocephalus*) *vetulus* O.F.M. occurs locally as conspicuous plankton constituent ; it was noted as *S. capensis* by Weltner. There seems to be no mention of observed morphological differences from the typical form in Europe.

All other Cladocera mentioned by various authors are not truly planktonic species ; they occur occasionally in the pelagic zone but not as permanent inhabitants.

The Copepods are treated according to the systematic arrangement proposed by F. Kiefer (1928), which applies a finer scale of generic differentiation than before but has proved useful.

Tropocyclops (*prasinus*) *confinis* Kiefer. This is the nearest determination possible at present for the form found in the Jinja basin of Lake Victoria, though the specimens examined do not completely conform with the descriptions, drawings and two keys by Lindberg (1955*a* and 1955*b*). Mrazek (1898) mentioned *Cyclops prasinus* Fischer in Lake Victoria as "one of the most characteristic forms of the Copepod fauna of Africa", Daday found it also without making more detailed remarks. Sars (1909) mentions a pelagic form *Cyclops tenellus* n.sp. from the plankton of Lake Tanganyika, but remarks that it does not occur in Lake Victoria. The former *Cyclops prasinus* represents a group of forms (22 in Lindberg's last key) which is distributed over temperate and tropical regions of the world, but concentrates in its density and racial differentiation in the warm water regions. In Lake Victoria it seems to be a regular member of the plankton of bays and nearer shore stations and insignificant in the open lake.

Mesocyclops leuckarti Clause is a less variable, cosmopolitan species, yet even the first observer noted that the Lake Victoria specimens differed from the European forms (Mrazek, 1898). Since then many observations have been made on the variability of this species but at present it is impossible to reach a conclusion as to the value of these variations. This is an important member of the plankton both in bays and in the open lake.

Thermocyclops is the name for a group of forms which like *Tropocyclops* are world-wide in their distribution but show a splitting out in numerous forms especially in the tropics. Not less than 15 species are recorded for Africa in a survey by Lindberg (1951*b*). In Lake Victoria the following forms or species have been listed :

Thermocyclops neglectus Sars ; this author coined the name C. *neglectus* as nom. nov. for a form synonymous with *hyalinus* Richard (not Rehberg) and the *C. oithonoides* found by Mrazek. This is a widely-spread species in Africa with a considerable variability not only in size. It is a regular member of the plankton in bays and open lake stations.

Thermocyclops emini Mrazek.—No doubt can exist about the validity of this remarkable species, which was first described from Lake Victoria by

Mrazek (1898) and later found in many other African waters. This is in Lake Victoria a true planktonic species.

Thermocyclops schuurmanae (Kiefer).—More doubts exist as to this species ; it may be the same as Mrazek's *Cyclops* sp. which in his opinion was near his *oithonoides*, mentioned above. Some specimens in an open lake sample could only be defined as conforming with Lindberg's data (1951*b*).

Other species named for the lake by authors are : *Cyclops oithonoides* Sars found by Mrazek, which was allocated by Sars to his *C. neglectus* ; *C. oithonoides* Schmeil found by Daday (1910) which may be the same as that of Mrazek ; the European *oithonoides* form does not appear in Africa.

Diaptomus galeboides Sars—This is the name given as nom. nov. by Sars (1909) to the species described by Mrazek as *D. galebi* Barrois. Daday also lists *D. galebi*, but both authors mention several differences from the typical *galebi*. Sars (1909) says that this a " characteristic plankton form " of the lake. He goes on :—" together with the usual form, there also occurred in the same sample a much smaller variety of somewhat more slender body and with the anterior antennae more elongated, but otherwise agreeing in all structural details exactly with the larger form ". Unfortunately the description of this and the following species came too late into the hands of the author of this report and no finer taxonomic differentiation could be made at that time ; both species are treated in Table II as one.

D. stuhlmanni Mrazek.—This species was described by Mrazek from the plankton of Lake Victoria, and confirmed by all other observers. Sars (1909) added some morphological remarks and found it numerous in two stations in the lake. Together with the previous species they form a very considerable proportion of the biomass of the zooplankton of the lake.

The typical *D. galebi* Barr. was noted by several of the earlier observers but erroneously ; it is a very important member of the zooplankton in the Nile from Egypt to the southern Sudan.

This completes the list of Entomostraca which form the Crustacean plankton of Lake Victoria. The decapod *Caridina nilotica* has also been noted by several authors as a constituent of the plankton.

3. Observations on the Horizontal Differentiation of the Crustacean Plankton.

Observations by previous authors indicated differences in the composition of the plankton at various stations in the lake, but only Worthington gives a table of percentage participation of components in one station. In order to contribute to the problem, 10 net samples from various points of the lake were examined by a uniform method. Eight of the samples came from a collection, which Dr. Lind (Makerere College) studied for its phytoplankton. These were collected in 1950 ; two samples were collected during the author's stay at Jinja especially for this purpose. Stations are :—

1. Pilkington Bay, 16.iv.1956
2. Njoga Sesse, 14.xii.1950
3. Bukoba, 4.viii.1950
4. Mwanza, 5.viii.1950
5. Musoma, 6.viii.1950
6. Busungwe, 4.viii.1950
7. Bukakata, 3.viii.1950
8. Kisumu, 7.viii.1950
9. Kisumu, 8.viii.1950
10. Open lake (north western corner), 26.iv.1956

Judging from the dates seven of these samples seem to have been taken during a circular steamer tour round the lake from Entebbe to Kisumu (3–8 August 1950) with a phytoplankton net ; some of them were shallow-water stations as seen in the admixture of shore, bottom forms and sediments. Only

TABLE II.—Percentage composition of Crustacean plankton in Lake Victoria in 11 net samples from 10 stations.

Species	Njoga Sesse	Bukakata	Busungwe	Bukoba	Mwanza	Musoma	Kisumu *a*	Kisumu *b*	Pilk. bay	Open lake	Worthington
Diaphanosoma excisum	—	3·0	0·4	—	0·3	1·0	—	1·0	3·3	4·7	2·3
Ceriodaphnia cornuta	—	9·0	1·0	—	1·0	—	2·0	—	2·0	8·0	
C. dubia	—	—	0·7	—	1·3	—	—	—	—	3·6	10·0
Moina dubia	1·3	1·7	0·3	—	—	1·0	—	1·0	26·7	5·0	
Daphnia longispina	—	0·3	—	—	0·3	—	—	—	—	5·0	24·0
D. lumholtzi	—	—	—	—	—	—	—	—	0·4	—	0·7
Chydorus sphaericus	—	18·3	18·7	12·6	3·4	0·3	—	—	1·0	2·7	—
Bosmina longirostris	1·3	4·7	7·3	—	0·3	1·7	2·0	1·0	1·6	1·0	—
Simosa vetulus	4·7	—	—	—	—	—	—	—	—	—	2·0
Total Cladoc.	*7·3*	*37·0*	*28·4*	*12·6*	*6·6*	*4·0*	*4·0*	*3·0*	*35·0*	*30·0*	*39·0*
Tropocyclops confinis (?											
♀	—	0·3	3·0	0·6	2·3	8·3	—	2·0	8·1	—	
♂	—	0·7	0·7	6·0	2·7	17·6	2·0	10·0	0·3	—	
juv.	—	—	—	2·0	—	13·7	—	—	—	—	
Mesocyclops leuckarti											
♀	30·0	2·0	0·3	0·6	3·3	3·7	—	—	3·6	7·0	
♂	2·0	3·0	0·3	2·0	2·3	0·6	—	—	0·3	3·7	
juv.	10·7	—	—	2·0	—	3·7	—	—	—	1·0	
Thermocyclops neglectus and *schuurmanae*											5·4
♀	31·7	2·7	—	—	7·3	2·7	—	—	2·3	16·7	
♂	0·3	2·3	—	—	3·7	1·7	1·0	2·0	—	0·3	
juv.	2·3	—	0·3	—	—	—	—	—	—	—	
T. emini											
♀	—	2·7	9·0	—	8·0	2·7	—	—	4·3	4·3	
♂	—	4·3	8·7	—	8·4	0·3	—	—	—	—	
juv.	—	—	—	—	—	—	—	—	—	0·7	
Cyclops juv. not determined	—	27·3	39·7	68·0	24·7	37·6	89·0	79·0	12·4	11·3	
Total Cyclopida	*77·0*	*45·3*	*63·0*	*81·2*	*62·7*	*92·6*	*92·0*	*93·0*	*31·3*	*45·0*	*5·4*
Diaptomus galeboides + *Stuhlmanni*											
♀	—	4·0	2·0	0·7	0·3	1·0	1·0	1·0	4·3	5·3	26·6
♂	—	2·0	0·3	0·7	1·7	0·7	—	1·0	2·0	3·0	18·7
juv.	1·0	11·7	7·3	2·8	28·3	1·7	1·0	2·0	26·7	16·7	4·8
Total Diaptomida	*1·0*	*17·7*	*9·6*	*4·2*	*30·3*	*3·4*	*2·0*	*4·0*	*33·0*	*25·0*	*50·1*
Corethra	4·3	—	—	—	—	—	—	—	—	—	0·5
Caridina	0·7	—	—	—	—	—	—	—	—	—	5·0
Non-planktonic	9·7	—	—	2·0	0·4	—	2·0	—	—	—	—
Total %	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*	*100·0*

Remarks.—The figures above indicate only that amongst the number of total organisms counted the particular species or stage occurred in the percentage given. The sign — indicates only that the particular organism was not found but does *not* mean that it was totally absent; the representation is only approximate and relative. *Daphnia barbata* e.g. is present in the lake according to previous observers but is not frequent enough to appear in our counts. *Thermocyclops schuurmanaes* and *Diaptomus stuhlmanni* were recognized too late to be separated.

one of the 10 samples is from the open lake and to amplify the picture Worthington's data have been added as an eleventh sample. His data are based on 13 vertical hauls from a depth of 67 m. made in one open lake station (north-eastern corner) with 3 hours interval. The 10 samples mentioned before were mostly surface hauls and are consequently not as representative of the true composition as the material collected by Worthington. The results are given here only as basis for future more accurate work.

Each sample was poured into a Petri dish and 3 × 100 specimens of Entomostraca counted at random, excluding nauplii; within the 100 specimens each species was noted down separately. Finally the percentage of each species in the total number of animals in each station was calculated. A table gives the results.

Conclusions from this comparative table can only be drawn with some reservations. The material is not uniform either in the method of collecting or in the time of collection. The exact positions of some of the stations are not known, but they can be deduced from the presence of shore forms or bottom sediments.

(1) Numerically Copepods prevail over Cladocera; in the 11 analysed samples they range from 50–96 per cent. Cyclopids are numerically stronger than Diaptomids in all stations nearer the shore, but in open water stations the Diaptomids become equal or even dominant over Cyclopids.

(2) The Cladocera seem to increase numerically in proportion to the other members in the more open stations where conditions apparently allow for the existence of a true plankton association. Bukakata, Busungwe, Pilkington and the open lake station have 28–37 per cent of Cladocera which tallies with Worthington's 39 per cent. Apparently inshore and shallow-water stations show a decrease of planktonic Cladocera: Njoga Sesse, Bukoba, Mwanza, Musoma and Kisumu show only 3–12 per cent and the number of species participating is smaller.

(3) The distribution of species is not uniform e.g. *Moina* in Pilkington Bay appears much more numerous proportionally than in other stations; similarly *Tropocyclops* in Musoma. But the material is inadequate to draw more detailed conclusions.

4. Appendix.

Some few observations were made on the food of two Cyclopids, *Mesocyclops leuckarti* and *Thermocyclops neglectus*.

Out of 20 *Mesocyclops leuckarti*, 5 had no animal remains in their gut, 1 no recognizable remains at all, chitin fragments from Copepods and Cladocera were found in 9, and two contained Rotatoria; of these 11, three had an admixture of algal food. Algae only were seen in 3 specimens. The 20 specimens comprised both sexes and large juveniles.

Twenty *Thermocyclops neglectus* contained no animal distinguishable remains; empty Melosira shells could be seen in 3 cases, otherwise a very fine mush with traces of minute algae and fine filaments.

These preliminary observations are too scanty to be of value and yet the problem calls for thorough investigations on clearly defined species. G. Fryer has paved the way for such work in his study *The Food of some Cyclopoid Copepods and its Biological Significance* which the author of the report has seen in typescript. His observations on *Mesocyclops leuckarti* agree with my few notes.

5. Remarks on Future Work.

Only Worthington has dealt with general problems of zooplankton; he studied vertical migrations of some of the more important components. No

quantitative assessment of zooplankton has been made in the lake and we do not know anything about the finer distribution. The food relations of the various components should be investigated on the lines shown by Fryer. These are all problems of some practical importance. It may be mentioned that an incidental observation of the phytoplankton mass recovered from the stomach of a *Tilapia esculenta* from Pilkington Bay showed in two slide smears over 50 Crustaceans, mostly juvenile Cyclopids, all in a digested state. These smears formed an insignificant part of the whole stomach contents and it can be deduced that Crustaceans add considerably to the diet of this important fish.

Finer problems such as variability, sexual processes in the Cladocera, and cycles of seasonal appearance promise to be very interesting. The purpose of this report is to make special investigations on the separate components of the Crustacean plankton easier.

Bibliography.

Lake Victoria.

Daday, E. 1907. Planktontiere aus dem Victoria-Nyanza. Sammelausbeute von A. Borgert 1904–1905. *Zool. J.* (Syst.), **25**, 245–262.

——. 1910. Untersuchungen über die Süsswasser-Mikrofauna Deutsch-Ost-afrikas. *Zoologica*, **23**.

Delachaux, Th. 1917. Cladocères de la région du lac Victoria Nyanza. *Rev. suisse Zool.* **25**, 77–93.

Gurney, R. 1928. Some Copepods from Tanganyika coll. by S. R. B. Pask. *Proc. zool. Soc., Lond.*, **22**, 317–332.

Mrazek, A. 1897–98. Copepoden Ostafrikas. *Deutsch-Ost-Africa*, **4**, 11, 1–11.

Sars, G. O. 1909. Zoological results of the third Tanganyika Expedition by A. Cunnington 1904–1905. The Copepoda. *Proc. zool. Soc. Lond.*, 1909.

Stuhlmann, F. R. 1888. Vorläufiger Bericht ... Reise Ostafrika. *S.B. preuss Akad. Wiss.*, 1888.

——. 1889. Zweiter Bericht ... *S.B. preuss. Akad. Wiss.*, 1889.

——. 1891. Beiträge zur Fauna zentral afrikanischer Seen. I. Südcreek des Victoria Nyanza. *Zool. J.*, **5**, 924–926.

Verestchagin, G. 1915. Some remarks on the fauna of Central Africa. (Title in Russian, this is Summary title.) Dogiel and Sokolov's ... *Zool. Exped. Brit. East Africa and Uganda.* Petrograd, **1** (5), 1–26.

Weltner, W. 1897. Die Cladoceren Ost-Afrikas. *Deutsch Ost-Afrika*, **4**, **10**, 1–12.

——. 1898. Ostafrikanische Cladoceren ges. von Dr. Stuhlmann 1888–89. *Mitt. Naturh. Mus. Hamb.*, **15**, 3–12.

Worthington, E. B. 1931. Vertical movements of freshwater macroplankton. *Int. Rev. Hydrob. & Hydrogr.*, **25**, 394–436.

Other references quoted.

Gautier, H. 1954. *Essai sur la variabilité, l'écologie, le déterminisme du sexe, et la réproduction de quelques Moina (Cladocera), récoltés en Afrique et a Madagascar.* Alger. Imprimerie Minerva.

Lindberg, K. 1951. Cyclopides (Crustacés Copépodes). *Explor. Parcs Nat. Congo Belge. Explor. Parc Nat. Upimbe Mission ... de Witte*, **2**.

——. 1951. Explor. Hydrobiologique du Lac Tanganyika (1946–47). *Res. Scient.*, **3**, 2 : 47–78 & tables. Inst. Royal Scien. Nat. Belgique.

——. 1955. Cyclopoides du Mexique. *Arkiv för Zoologi*, ser. 2, **7**, 23, 459–488.

——. 1955. Cyclopoides récoltés au Perou ... *Folia Biologica Andina.* II *Zoologia*, **1**, 1–18.

Rzóska, J. (in press). On the variability and status of the Cladocera *Ceriodaphnia cornuta* and *C. rigaudi*. *Ann. Mag. Nat. Hist.* 1956.

Woltereck, R. 1930. Alte und neue Beobachtungen über die geographische und die zonare Verteilung der helmlosen und helmtragenden Biotypen von Daphnia. *Int. Rev. Hydro. Hydrogr.*, **24**.

Fryer, G. (typescript). *The Food of Some Cyclopoid Copepods and its Biological Significance.*

Summary.

The history of investigations on the Crustacean plankton of Lake Victoria is shortly reviewed. The gradual establishment of a faunal list is presented in a

table. Remarks on the component species show that even the finer taxonomic analysis of some of the species has not yet been accomplished, because of the variability of some of the species and its dependence upon complex physiological and ecological influences. A limited number of plankton samples was available to allow for a preliminary discussion on the composition of the Crustacean plankton in various parts of the lake. A table summarizes the results and shows considerable differentiation. Few remarks on the food of two Cyclopids are added. The report closes with remarks on some desirable aspects of future work.

PRESIDENTIAL ADDRESS

Plant Morphology and the Evolution of the Flowering Plants.

By H. Hamshaw Thomas.

It is remarkable that although nearly a century has passed since the belief in the special creation of all living species was seriously challenged, and although evolution has, in essentials, been accepted by all scientists, no real progress has been made towards an understanding of the chief problem of plant evolution, the origin and development of the flowering plants. When one considers the very great progress made in the investigation of every aspect of the plant world during the past sixty years, it is strange that we have found no definite evidence to show that, in fact, the multitude of angiosperms in the world to-day have arisen by evolutionary processes. We have acquired much knowledge of the genetical, cytological and physiological events that occur in the life of the higher plants. Physiological and biochemical researches have displayed the complexity of the materials which make up the plant body. We can readily appreciate the mechanisms by which changes may occur which lead to the appearance and spread of new varieties and species, but we have scarcely a clue as to the evolutionary relationships or probable past history of the members of this large group. Can we be content to hold merely as an article of faith the belief that the angiosperms have evolved from simpler forms, without requiring some good evidence? Few botanists can be entirely indifferent to this question, and zoologists are to some extent concerned, since the food of so many animals is provided by the flowering plants. It would thus seem appropriate for your president to deal with this subject, since, in two years' time, we shall celebrate the communication to this society of the famous papers by Darwin and Wallace.

Now if we look at the history of science we shall find that in almost every branch of knowledge the investigation of the mysteries of Nature seem at some period to have reached an impasse, due, not to the inability of men of science to devise experiments or to make observations, but owing to the incompatibility of the results of new work with well established views. You will remember the limitation to the progress of astronomy imposed by the geocentric view of the universe. The study of plant nutrition was baffled by the Aristotelean theory that the food of plants was all extracted from the soil. The progress of chemistry was halted during the latter part of the eighteenth century by the doctrine of phlogiston. Towards the end of the nineteenth century plant physiology was retarded by the belief in the all-powerful action of vital forces which were beyond the reach of investigation. In all these examples the dead weight of opinions long held, and therefore regarded as firmly established, checked new investigations; additional observations only seemed to add to the complexity of the problems involved. But, in truth, the old and mistaken conceptions, the result of man's ignorance of natural

phenomena, and the unquestioned reliance on the views received from previous generations, were the main impediments to progress.

We may therefore learn from history that when a branch of science seems to have reached an impasse, this may be broken, not only through the production of new observations, but also by a critical examination of any basic suppositions that enter into our attempts to frame generalizations explaining the known facts.

It is not my intention to discuss all the views and arguments that have been put forward about the origin of the flowering plants, but rather to consider the philosophical foundation of the theories of the last sixty years. I do not wish to imply that the work of those who have attacked the problem has been without value. On the contrary, it has directed attention to many aspects of the question, and has shown that little progress could be made in the direction indicated by current views on the probable form of the primitive angiosperms.

In my view the approach to the problem has been defective in that it has been based almost entirely on morphological considerations. The results of evolution may become evident in structural features, but it is not enough to confine our attention to these features alone. We must think of plants as living objects of a material nature, rather than as units in a mental puzzle. The ability of species to flourish in their particular environments, to spread, to become adapted physiologically to changed environmental conditions, and to throw off viable mutations must be taken into account. This means that their physiological and cytological make-up, together with their biochemical constitution, may well be as important as their external and internal structure.

During the last few years the studies of Mr. E. J. Corner on comparative biology have brought a breath of fresh air into a somewhat stale atmosphere. They form a valuable contribution to our evolutionary problems. The probable relations between animals and plants, both at present and in the past, need careful consideration. We should also look at vegetative structures in relation to the climatic factors of their environment, as Prof. Holttum has done in his recent paper on Monocotyledons, remembering that widespread changes in climate have undoubtedly taken place repeatedly in the past.

It has long been hoped that the study of fossil plants would furnish the key to the problem of the flowering plants. But here again, at first sight, little evidence seems to be forthcoming in spite of the enormous additions to our knowledge of the plants of the past made during the last hundred years. But the fossil record does provide a considerable bulk of evidence of plant evolution and if properly used it may contribute much to our particular problem. I hope that on another occasion I shall be able to deal with this subject in the light of what I have to say to-day.

In 1932 I ventured to draw the attention of Fellows of this Society to some of the inconsistencies which had arisen between what I called the Old Morphology, Typology, as we may call it to-day, and the results of evolutionary studies, which I termed the New Morphology. This paper provoked some discussion, but it soon became evident that I had not succeeded in making clear the underlying philosophical distinction between the old approach to the comparative study of plant form and the new evolutionary outlook. Subsequently Prof. Troll, in the introduction to his comprehensive work on the *Comparative Morphology of the Higher Plants*, gave a good account of the principles underlying typology, and more recently Dr. Agnes Arber has given to English readers an admirable survey of the philosophical principles underlying the study of plant form by the classical method. (*The Natural Philosophy of Plant Form*. 1950.) She should have made clear the difference between the viewpoints of those who follow the typological aim and those who adopt the evolutionary method.

It seems, however, that even now many botanists have not appreciated the essential difference between the old morphology of the nineteenth century and the new morphology of the twentieth. It is clearly difficult to understand that a great gulf exists between the logic of Goethe and his followers and the philosophy which we employ when we study form and structure from the evolutionary aspect. The distinction is all the more difficult since typology and the study of form based on phylogenetic concepts are both valid scientific modes of approach to similar problems.

Thus in 1950 Prof. Eames poured scorn on what he called the New Morphology, when he criticized Prof. Lam's scheme of the phylogenetic relationships of plants. But Eames himself is a most distinguished exponent of the New Morphology. He is interested in phylogeny ; he appears to admit the evidence of cytology, genetics and palaeobotany. But in the Old Morphology cytology, genetics, palaeobotany and phylogeny have no place, and only recently has anatomical structure been admitted as a source of valid information.

Morphology arose as an idealistic concept originating in the climate of thought of the early nineteenth century. Since it was then considered that all species had been created as distinct entities their form relationships could only exist as ideas in the mind of the observer. Comparisons could be made by reference to an *urform*, a plant composed only of stem, leaves and roots. This was not the representation of any plant now living or which had ever lived, but it served as a standard of comparison by reference to which all forms could be compared. Evolutionary morphology, on the other hand, looks at plants as living organisms, whose form is believed to possess relationships of a material kind, arising from the fact that they are in some way genetically connected. Similarities would exist even though they had never been seen by man. No constructional standard of reference can be set up, for all are thought to have arisen by the differentiation of a primitive thallus, and it is very doubtful if any material distinction should be drawn between stems and leaves. Since we are intimately concerned with the historical connections between living organisms, their form cannot be considered alone ; physiology, genetics, cytology, anatomy, palaeobotany, and also environmental conditions all need consideration. The form of a plant and its organs is the outcome of the reaction of a living protoplasmic complex with its environment over a long space of time.

We are so familiar with modern evolutionary ideas, and so far away from the climate of thought of the naturalists who believed in the special creation of the objects in the world at a not very distant period in the past, that we may well find it difficult to understand the metaphysical nature of the Old Morphology. But it is essential to understand how its principles were reached and what they really meant, to see why they are inapplicable to evolutionary concepts. For this purpose we must take a brief look at the past.

Some scientists consider that the history of science has little or no bearing on present-day investigation of natural knowledge. But real science is not just the random collection of observations or the performance of experiments. We are led to make observations by the fundamental ideas in our minds. The interpretation of results will depend very largely on the views which form our scientific background, and will often be based on notions which have come down to us from our predecessors. This makes it necessary for us to know why the earlier scientists formulated certain views, what these views really meant to the men who originated them, why and how they spread, and how their meaning may have become altered with the passage of time.

We have to go back to the philosophers of ancient Greece to find the beginnings of thought about the forms of natural objects, and to Plato rather than Aristotle. Plato held that behind the changing appearance of things there is an idea, or form of a thing, which is an unchanging reality. The

discussion of this idealistic concept occupied very largely the mediaeval philosophers. The Schoolmen discussed, often with intense vituperation, whether the universals or idealistic concepts had a real existence outside the world of sense, or whether they were merely abstract conceptions of the intellect. During the sixteenth and seventeenth centuries many contrasts between the concepts of the Schoolmen and the actual facts of nature became plain. But even as late as 1660 we find Kinelm Digby, in a lecture to the society that was soon to become the Royal Society, claiming that the circular section of the stem of a plant was due to its partaking of the nature of fire.

The ever widening of knowledge, and the discovery during the eighteenth century of large numbers of plants and animals previously unknown in Europe, acted as a strong stimulus towards the recognition of universal ideas epitomizing their varied forms. The philosopher Kant laid it down that the ability of man to perceive the ideas of things distinguished him from animals, which were only able to perceive the things themselves. The problem was to discover and define the ideal of plant structure from the contemplation of all the forms that God had created. This was the task towards which Goethe's *Versuch die Metamorphose der Pflanzen zu erklären* was directed, and as you well know his solution was that plant organs are referable to three categories, stems, leaves and roots, while leaves may appear under varied forms, including bracts and the parts of the flower. The manifestation of the idea of the leaf in the different regions of the plant was termed metamorphosis, signifying that the change in form of the leaf, as the eye passes up the plant from cotyledons to carpels, is not an objective change but a conceptual modification.

Goethe devoted a section of his essay to the work of one of his predecessors, and on this 249th anniversary of the birth of Linnaeus I must devote some attention to his morphological theories. These are mainly to be found in the dissertations of his pupils in the *Amoenitates Academicae*, where there are four dissertations dealing with buds, bulbs and floral structures. Dissertation No. 24, *Gemmae Arborum*, by P. Loefling, dated 1749, dealt with the structure of buds and of bulbs, recognized as analogous to them. In 1755, dissertation No. 66, by N. E. Dahlberg, has the title *Metamorphosis plantarum*. In it the development of buds and of flowers is considered. The development of the flower was compared with the metamorphosis of animals, especially with the emergence of insects from the pupa ; the floral parts were regarded as coming forth from successive tissues of the stem. The cortex, or outside bark, was thought to give rise to the calyx, after which the inner bark bursts through to give the corolla ; the stamens originated from the wood, and the pistil from the medulla, or pith. In the tenth edition of the *Systema Naturae* Linnaeus identified the parts of the flower with the parts of a bud, which he regarded as providing for the growth of the plant for six years. The leaves of the plant are the creation of the present year, bracts of the second year, calyx of the third, petals of the fourth, stamens of the fifth and pistil of the sixth. Similar views are found in dissertation No. 118 of 1760, under the name of H. Ulmark, which has the title *Prolepsis plantarum*. Here the idea of the bud containing the leaves for six years is supported by the argument that " just as among animals we find the little *Volvox globatur* containing within the mother its children, grandchildren, great grandchildren and great-great grandchildren down to the sixth generation ". The unfolding bud was compared with the emergence of a butterfly from a pupa, and, it is noted that as the leaves are exposed other buds are found in their axils. By cultural changes a plant which has flowered for successive years can be changed so that it produces vegetative parts only, so it is argued, leaves and branches can be produced from the provision made for flowers. Evidence for the nature of floral organs is next considered. The bulbs of Hyacinths and Ornithogallums appeared to show that bracts

are nothing but the leaves, which would have developed in another year if the plant had not flowered and drawn off part of their nutriment. The calyx was shown to be only approximated leaves by the frequent expansion of the calyces of Pyrus and Mespilus into perfect leaves. The flowers of other genera supported this. As it is often difficult to distinguish the petals from the calyx, as in *Helleborus niger* and other flowers which may develop green corollas, the petals were thought to represent rudimentary leaves within the calyx leaves ; they would have become leaves if the plant had not flowered. Stamens were regarded as leaves since their position in respect of the petals was that of an axillary bud, and because in double flowers stamens change into petals. Evidence for the foliar nature of the pistils is not so clearly stated, but the flowers of *Carduus heterophyllus* were thought to show that pistils were also leaves. The dissertation ends with a recapitulation of the view that the floral organs represent parts formed in the bud for six years. Ferber's dissertation of 1763, also under the title of *Prolepsis plantarum*, is largely concerned with what may be termed the physiological aspect of bud formation and plant nutrition.

The ideas of Linnaeus on morphology seem worthy of consideration since they do not appear to be well known, and because they show that the term metamorphosis was used for plants before Goethe, and that the idea of the floral parts being modified leaves was taught by the great master.

Goethe's famous treatise came thirty years later. He rejected the mediaeval notion of preformation, used the term metamorphosis with a somewhat different significance, and gave the whole matter a concise and philosophical form. He pointed out that Linnaeus had not paid attention to annual plants, from the observation of which he had himself started. We are much indebted to Dr. Agnes Arber for her new translation of Goethe's essay, and for her interesting notes and comments upon it (*Goethe's Botany*). She has reminded us that he was describing the process by which one and the same organ presents itself to our eyes under protean forms. " That which in Idea is the same, may in experience appear either as the same, or similar, or even as entirely different ". The Idea was the Platonic notion modernized by Kant. It had no evolutionary or even materialistic significance. The urform was a mental concept which " could neither be described adequately in words nor represented pictorially ".

It would appear that Goethe's essay obtained little recognition among botanists until a number of years had passed, but then in quite a short time it was considered as initiating a new aspect of plant study. Morphology, as Goethe called it, became almost equal in importance to descriptive botany and taxonomy. In my view this was mainly due to the rise of Nature Philosophy, to which the Versuch formed the first important and most lasting contribution. This early nineteenth century philosophy bears a strong resemblance to the teachings of the late mediaeval Neo-Platonists in Italy, in expressing the belief in a certain unity of structure of all natural objects, animate and inanimate. Intuition was relied upon as the sure guide to truth, and the microcosm reflected the macrocosm.

The development and spread of Nature Philosophy has received little attention from historians of biology. I believe that it is virtually unknown to scientists to-day. It probably contributed nothing to our knowledge of plants and animals, but it is important to those interested in the development of scientific thought. It was an attempt to form generalized concepts of the world of Nature within the belief of special creation. It was an attitude of mind which came to fruition in concepts like the atomic theory, the doctrine of the conservation of energy, and the theory of evolution. Many of its wild speculations led to a search for reliable facts. Although much of it is preposterous

in the light of modern knowledge, it contains concepts which in a somewhat different form have become part of our generally accepted system of thought. Lindley in criticizing the views of some of those philosophers who held that there were certain numbers of universal significance, which had to be used in the classification of plants, thought that the doctrine that numbers are principles of all things, was quite absurd. But to-day the importance of numbers is a basic part of our ideas of molecular and atomic structure. Newton's theory of the all-pervading ether, was revived by Oken and credited with some truly astonishing properties. Later the ether played an important part in the physical theories developed by Clark Maxwell and others. Schelling's belief in electricity and magnetism as the unity principle in all things, is not so far from our modern views on the constitution of matter. All these early strivings after a synthesis of current knowledge, attracted many of the keen young biologists of the time, some of them migrated to Munich when Schelling became professor of philosophy there in 1828. Schelling was a friend of Goethe, who extended his patronage to some of the younger members of this school, and made further contributions to the movement by his studies on the skeleton of vertebrates, and on the spiral tendency in vegetation.

I cannot attempt to outline the doctrines of this period, which aimed at a pure conception of Nature, and spread out into a grand scheme which embraced not only all natural objects, but the state, art and the history of the world. They had a considerable influence among European biologists, especially in France and Germany. In Sweden Elias Fries, the mycologist, produced a Philosophical View of Nature and a classification of plants based upon it. In England it was perhaps more critically received, and Lindley devoted a chapter of his *Introduction to Botany* (1832) to a refutation of its application to taxonomy. However, a translation of Oken's *Physiophilosophy* was published by the Ray Society in 1847 which shows that this really astonishing book was valued by many biologists. Lindley and many others accepted Goethe's idea of the metamorphosis of plants, and Owen advocated the companion doctrine of Goethe and Oken on the vertebrate skeleton.

It was in this climate of opinion that morphological study became established and from about 1830 Morphology became an integral part of botanical study. The comparison of plant forms by reference to ideal types was steadily developed by many investigators, such as Schimper, Alexander Braun, Von Mohl, Robert Brown, De Candolle and Schleiden. The text-books published during the middle of the nineteenth century provide evidence of the importance attached to this typological study. Goebel in his *Life of Hofmeister* remarks that in 1867 the idealistic morphology was so well established that Hofmeister's book on *Causal Morphology* received little attention, though it threw down the gauntlet to idealistic morphology. To many, a change in our conceptions of organs meant a change in the things themselves, a classical mode of thought which was not accepted by Nageli and some other botanists. Among these was Prof. J. Hutton Balfour, known to his students as "Old Woody Fibre", who made a very clear statement in his *Class Book of Botany* in 1852. He said "The leaves and the different parts of the flower are considered by botanists as homologous. In other words they are constructed on the same plan and the forms which they assume depend on the functions which they are required to perform". . . . "The leaf is considered as the *type* of all. This idea was started by Linnaeus and was afterwards more fully brought forward by Goethe. In speaking of the parts of the flower as metamorphosed or modified leaves, it must not be supposed that we mean that these parts have, at any period of their existence, been true leaves. All that is implied in the statement is that both are formed on the same general plan, both are arranged on the same principle, and that one law pervades their morphology". . . . "This morphological

view of the organs of the flower associates them with leaves in a very interesting manner, and enables us to give a philosophical exposition of the harmonies subsisting between them."

The communication to our Society in 1858 of the papers by Darwin and Wallace led to a different exposition of the similarities between floral and foliage leaves. This came about by the simple expedient of identifying the mental process, hitherto termed metamorphosis, with the materialistic concept of adaptation. There can be little doubt that this illogical procedure, which was so widely accepted, was largely due to Sachs, whose great *Text-Book of Botany*, published in 1868, had such a wide influence on the teaching of botany throughout the world. The first part of this book deals with the morphology of the higher plants in a similar manner to that adopted by his predecessors. The term metamorphosis was very frequently used. At the end of the book, in the section dealing with plant physiology, there is a chapter on the origin of species. In this he says that metamorphosis is to be understood as the adaptation to various physiological purposes of morphologically equivalent members. Metamorphosis, adaptation and purpose are synonymous. Strasburger and his collaborators followed the same plan in separating morphology from physiology, but stamens and carpels were now called sporophylls. There seems to be no appreciation, in these very influential works, of the distinction between a philosophical system solely based on the perception of form by the eye, and the materialistic view of the plant world, in which genetic relationships exist between the organisms themselves, which are independent of man's observations and which may be only discernible from the results of cytological investigation or chemical experiments.

The spread in England of the doctrine that the parts of the flower are leaves that have become modified, was also assisted by the publication of Bentham's *Handbook of the British Flora*, and of its subsequent editions edited by Hooker. In the introductory part we were told that " the parts of the flower are considered as leaves ", and, as compared with bracts, " still further altered in shape, colour, and arrangement round the axis, and often more or less combined with each other. The details of this theory constitute the comparatively modern branch of Botany called Vegetable Metamorphosis or Homology, sometimes improperly termed Morphology ". This passage appeared in 1858, and was written when Bentham believed in the constancy of species and special creation, though he later accepted Darwin's views. But the statement continued to appear unchanged in editions of Bentham and Hooker's *Flora*, down to 1912.

The concept of stamens and carpels evolving from sporophylls with leaf-like attributes, brought about difficulties and discussions, acutely felt at one time, but now conveniently neglected. From what kind of sporophyll had the stamen evolved, how were the sporangia borne upon it? What was the nature of the ovule and its integuments, were the latter also leaves, and so on? But the appearance of Darwin's great work had raised such keen controversy as to whether the doctrine of special creation was fact or fiction, that botanists scarcely realized the fundamental change which the evolution theory had brought into the study of plant form. So at the turn of the century they devoted much time to the problems of the interrelationships of plants from the phylogenetic standpoint, without reference to the philosophical questions involved. Of this Dr. Arber (1950) very aptly writes, " To many workers at that time the diversion of biology into historical channels was a welcome relief, since it transformed theoretical botany into something material, amenable to picture thinking, and not demanding difficult mental activity of a metaphysical kind. Thus, by a feat of legerdemain, which seems to have passed almost unnoticed, the Ancestral Plant was substituted for the

Archetypal Plant, and those characters which had, with reason, been attributed to the mental conception of the architype, were, without further justification, assumed to have been proven for an actual historically existent ancestor ".

This transfer of ideas led to another conceptual development of doubtful validity. Stamens and carpels were accepted as modified leaves; ferns and some lycopods bore their sporangia on leaf-like structures. Hofmeister's work had shown that anthers and ovules were closely comparable with micro-and-mega sporangia. Consequently it was assumed that in all vascular plants the sporangia were borne on fertile leaves or sporophylls. This was a logical fallacy, and it led to the elaboration of several imaginary, and even fantastic schemes, such as those which endeavoured to explain the structure of the cones of the living and fossil members of the Equisetales, a group in which the sporangia have always been borne at the tips of delicate branch-like structures. The attempts to interpret the reproductive structures of the gymnosperms in terms of the sporophyll doctrine also led to difficulties, which in the case of the ovules of Gnetum and of the Bennettitales had to be explained by the hypothesis that in these plants the sporophylls had completely disappeared, leaving no trace of their former presence. The important palaeobotanical discoveries made during this century did little to disturb the older ideas. Dr. D. H. Scott said once that they had raised more problems than they had solved.

It is not unlikely, then, that the illogical and unproved transfer of ideas from typological to evolutionary morphology, has been one of the main reasons why our attempts to solve the problems of the origin of the flowering plants have met with so little success. I should now like to make a few remarks of a more positive nature.

If plants and plant structures are to be studied from the evolutionary point of view it is not enough to try merely to arrange them in a sequence with reference to their forms. The causal aspect must be studied, and consideration given to what is known of the physiology of reproduction. Goethe, like Linnaeus, thought that the production of flowers may depend on the state of nourishment of the plant, but little seems to have been done on this problem before the work of Klebs in the closing years of last century which indicated that the problem was not a simple one. In recent years much important work has been done on the causes of the change from vegetative growth to the formation of flowers. The investigations of a large number of botanists on the effects of day length, on vernalization, and on the results of treating plants with auxins and other substances affecting growth, have shown that the initiation of the reproductive structures and their subsequent growth to maturity are due to complex changes in the biochemical content of the cells of the plant. Although the mechanism of flower production is still far from completely proved some features have emerged from all the different types of investigation which seem to be well established. The changes in the primordia at the tips of vegetative branches leading to the appearance of floral organs, are due to the arrival of minute traces of certain substances, auxins or anti-auxins, which are generated in the vegetative leaves and pass to the shoot apices. The nature of these substances is not yet known, but it appears that comparable substances occur in the algae and fungi. It would seem, moreover, that the formation of stamens and carpels does not occur until a certain critical concentration of the flower-producing substances has been attained in the growing apices. If this is correct it may well indicate why lateral organs of a form intermediate between that of the vegetative leaves and the stamens or carpels, the bracts, bracteoles, sepals and petals generally precede the appearance of the reproductive structures. These intermediate structures may be due to the appearance in their primordia of auxins below the concentration necessary for the completion of the flower.

Considerations of this kind may well explain why the petals in some flowers closely resemble the sepals while in other families they appear to be expanded sterile stamens. A few years ago Dr. Melville suggested at one of our meetings that this physiological work merited the close attention of taxonomists, and I feel sure that it is of great significance in the consideration of floral morphology from the evolutionary aspect. It seems to make it unlikely that stamens and carpels have ever been foliar structures in the objective sense, and probably requires a completely new view of floral morphology, a view which would be more in accord with the evidence which we possess from the fossil gymnosperms. The floral organs resemble both leaves and stems in certain aspects of their structure and development, since all parts of plants are formed of very similar cells. But their assignment to one of these categories or the other is purely a mental and philosophical matter.

If time allowed I should like to discuss the influence of genetics on floral morphology from the evolutionary standpoint. But I must, at least, remind you of one well known but important point. The mode of thinking engendered by belief in the constancy of species made us think of species as separate morphological units. In trying to distinguish a relatively primitive plant we look for one in which each character is primitive. In seeking for a fossil ancestor we hope to find one which has all the characters of a flowering plant. But one of the earliest discoveries in genetics was that characters can be inherited separately, or rather in groups which are independent. We must therefore not place too much stress on the occurrence of a single character, such as the possession of free petals. It is likely that in the course of the evolution of a genus the different characters, floral and vegetative, will tend to keep in step to some extent, but we cannot rely on this unless supported by approved statistical correlation.

May I conclude by saying that while evolution appears to provide the only tenable hypothesis explaining the varied flora of the world to-day, this hypothesis is still unproven. The probable reason for this is that we have approached the subject with preconceptions. We have been convinced that we knew what the more primitive flowering plants looked like, but this was due to illogical reasoning, in consequence we have probably been searching for a chimera which has never existed. The position to-day might have been very different had botanists discarded the idealistic view of the flower in the same way that zoologists abandoned the theory of Goethe and Oken that " the head is none other than a vertebral column and that it consists of four vertebrae ". I believe that we must make a fresh start in the investigation of our great problem, treating plants as living organisms, and paying great attention to the logic of our arguments. We shall probably need to adopt new methods and new criteria, and if this is done, the problem may not prove to be as insoluble as it appears to-day.

SYSTEMATICS ASSOCIATION

ANNUAL REPORT XV (1955–56).

The fourteenth Annual General Meeting was held in the Lecture Room of the Museum of Zoology, the Department of Zoology, Downing Street, Cambridge, on Saturday, 21 May at 9.30 a.m. A soiree preceded the meeting on the evening of 20 May and an excursion to Wicken Fen, under the leadership of Dr. S. M. Walters, followed on 22 May.

The Genus and Subgenus.

A symposium with this title followed the Annual General Meeting on 21 May 1955. The discussion was opened by Dr. A. J. Cain, Mr. E. A. George, Mr. R. D. Meikle and Mr. H. L. G. Stroyan.

Taxonomic Criteria.

A meeting of the Association was held at the Royal Botanic Garden, Edinburgh on 16, 17 September 1955. Three sessions were devoted to a discussion of the criteria of species (introduced by Prof. I. Manton), a criteria of genera (introduced by Prof. T. G. Tutin) and criteria of families (introduced by Dr. E. J. H. Corner). A soiree was arranged for Friday evening, 16 September, when Dr. P. H. Davis outlined the results of the Vacation Course in the Practice of Herbarium Taxonomy given at Edinburgh University earlier in the week. An excursion to the Scottish Society for Research in Plant Breeding, Roslin (by invitation of Dr. J. W. Gregor) followed the morning session of the 17 September.

Existing financial commitments have prevented the publication by the Association of papers read at the Cambridge and Edinburgh meetings, but it is hoped that at least some of the papers may yet be published elsewhere, and that reprints may be available for members.

Species Concept in Palaeontology.

Council has arranged for the publication of 2000 copies of this series of papers, and has agreed that members should be allowed to purchase one copy at a reduced price.

The Vice-Counties Map.

There is little hope of this being completed in the near future.

New Prospectus.

Council has agreed to the publication of 1000 copies of a new prospectus, with a copy of the recently amended rules attached. Copies will be made available to the Society of Systematic Zoology (U.S.A.) and, by agreement, copies of that Society's prospectus will be available for members of the Systematics Association.

Biological Abstracting Services.

Dr. B. P. Uvarov attended, as the Association's representative, a conference held in the rooms of the Royal Society on 1 December 1955. The object of the Conference was to discuss means of improving existing abstracting services and of amalgamating Biological Abstracts (U.S.A.) with British Abstracts

of Medical Sciences into a single International service. Dr. Uvarov reported that the majority of delegates present preferred several specialized services rather than a vast comprehensive one ; many of the delegates were dissatisfied with *Biological Abstracts*, and British delegates felt that many sciences were already well served by British abstracting services, particularly those of the Commonwealth Bureaux. The proposals received little support, but it was suggested that the Royal Society might appoint a panel to study the problem.

Taxonomic Principles Committee.

Mr. John Lewis (Kew) succeeded Mr. P. Sylvester-Bradley as Convener of the Committee after the 1955 Annual General Meeting, and, in January 1956, circulated to all members of the Association, a questionnaire designed for the purpose of finding out the best policy to be followed by the Committee in planning its future activities. Mr. Lewis will be reporting on the replies received at the 1956 A.G.M.

What is the Subspecies?

An informal discussion with this title was held in the rooms of the Linnean Society on Thursday 8 March 1956. The chief speakers were Prof. J. Heslop-Harrison, Dr. Maurice Burton, Dr. S. M. Walters and Dr. A. J. Cain. The meeting was attended by 71 members and guests, and it is hoped that a short account of the discussion will soon be available for distribution to members.

SYSTEMATICS

General Account

Income	£	s.	d.
Balance at Westminster Bank 6 May 1955	175	7	1
Annual subscriptions	40	0	0
Donation		15	0
Clarendon Press: royalties on "The New Systematics"	15	17	6
Sales of Publication No. 1	24	3	8
	£256	3	3

Special Account

	£	s.	d.
Balance in Post Office Savings Bank 6 May 1955	399	2	5
Life Memberships—8	40	5	0
Sales of Publication by Agents, to 31 March 1956	13	2	6
Transfer from General Account *re* sales of Publication, 1954–55	17	13	5
Interest 1955	10	5	1
Due from General Account *re* sales of Publication by Hon Treasurer, 1955–56	24	3	8
	£504	12	1

Balance Sheet

Liabilities	£	s.	d.
Founder and Life Members—50	250	0	0
Annual subscriptions in advance—103	25	15	0
Sundry creditors:			
Harding: expenses of			
Hon. Zoological Secretary to 9 May 1955	4	14	6
Hon. Secretaries 1955–56		10	4
Sylvester-Bradley: duplicating material *re* Symposium and Taxonomic Principles Committee	3	5	11
Excess assets over liabilities	606	17	3
	£891	3	0

Audited and found correct—
VICTOR S. SUMMERHAYES,
E. MILNE-REDHEAD.
31 October 1956

ASSOCIATION

1955–56

Expenditure	£	s.	d.
Hon. Treasurer's expenses (1 May 1955—5 May 1956)	2	12	4
J.P. Duplicating Services : making up addressing machine cards	6	2	8
Couldrey & Co. : duplicating paper		15	0
Institute of Biology : secretarial services and materials to 31 March 1956	10	3	0
F. J. Milner : overprinting letterpaper		15	0
St. John's College, Cambridge : meeting 20 May 1956	2	1	3
Westminster Bank : draft stamp			2
Transfer to Special Account *re* sales of Publication, 1954–55	17	13	5
Eadon Engraving Co. : block-making for Publication No. 2	21	17	10
Balance at Westminster Bank 23 May 1956	194	2	7
	£256	3	3

1955–56

	£	s.	d.
Balance in Post Office Savings Bank 23 May 1956	480	8	5
Due to General Account *re* block-making for Publication No. 2	21	17	10
Difference in General Account	2	5	10
	£504	12	1

May 25th, 1956

Assets	£	s.	d.
Balance in Post Office Savings Bank	480	8	5
Balance at Westminster Bank	194	2	7
Subscribers one year in arrear, 48 @ 4*s*.	9	12	0
Subscribers two years in arrear, 27 @ 4*s*.	5	8	0
Publication No. 1 : copies			
In hands of agents, 25 March 1956, 100			
In hands of Hon. Treasurer, 25 May 1956, 473			
Sold recently but not settled, 3 (576 @ 7*s*.)	201	12	0
	£891	3	0

G. J. KERRICH,
Honorary Treasurer,
24 October 1956.

PRINTED BY ADLARD & SON, LTD.
BARTHOLOMEW PRESS, DORKING.

THE LINNEAN SOCIETY OF LONDON

BURLINGTON HOUSE, PICCADILLY, LONDON, W.1

SOME SPECIAL PUBLICATIONS.

A Catalogue of the Linnaean Herbarium, compiled and annotated by Spencer Savage (1945). (Pp. xvi + 226, frontisp., 8 plates and pull-out leaf.) 60s. net.

Synopses of the British Fauna :—

No. 1. *Opiliones* (*Arachnida*) *or Harvestmen.* By Theodore H. Savory. (2nd Edition.) (1948.) 2*s.* net.

No. 2. *Caprellidea* (*Amphipoda, Crustacea*). By R. J. Harrison (1944). 1*s.* 4*d.* net.

No. 3. *Gammaridae* (*Amphipoda*) ; *with Key to the Families of British Gammaridea.* By D. M. Reid (1944). 3*s.* 4*d.* net.

No. 4. *Freshwater Bivalves* (*Mollusca*),—(*Corbicula, Sphaerium, Dreissena*). By A. E. Ellis (1946). 2*s.* 6*d.* net.

No. 5. *Freshwater Bivalves* (*Mollusca*),—(*Unionacea*). By A. E. Ellis (1947). 5*s.* 0*d.* net.

No. 6. *Lumbricidae* (*Annelida*), *with a Key to the Common Species.* By L. Cernosvitov† and A. C. Evans (1947). 2*s.* 6*d.* net.

No. 7. *Talitridae* (*Crustacea, Amphipoda*). By D. M. Reid (1947). 2*s.* 6*d.* net.

No. 8. *Slugs* (*Mollusca*),—(*Testacellidae, Arionidae, Limacidae*). By H. E. Quick (1949). 2*s.* 6*d.* net.

No. 9. *British Woodlice, with a Key to the Species.* By E. B. Edney (1954). 5*s.* 0*d.* net.

No. 10. *Pseudoscorpiones, with a Key to the Species.* By G. Owen Evans and E. Browning (1954). 3*s.* 0*d.* net.

Catalogue of the Printed Books and Pamphlets in the Library of The Linnean Society of London. (Pp. 860.) (1925). 13*s.* 4*d.* net.

General Index to the first Twenty Volumes of the Journal (*Zoology*). . . . (Pp. 437.) (1896.) 6*s.* 8*d.* net.

General Index to the first Twenty Volumes of the Journal (*Botany*). . . . (Pp. 428.) (1888.) 6*s.* 8*d.* net.

The Darwin-Wallace Celebration held on Thursday, 1st July, 1908, *by the Linnean Society of London.* (Pp. 118.) (1908.) 3*s.* 4*d.* net.

Catalogue of The Manuscripts in the Library of The Linnean Society of London.—Part 1. *The Smith Papers.* (*The Correspondence and Miscellaneous Papers of Sir James Edward Smith, M.D., F.R.S., first President of the Society.*) By Warren R. Dawson. (Pp. 114.) (1934.) 13*s.* 4*d.* net.

[*Continued overleaf*

SPECIAL PUBLICATIONS (*continued*)

Catalogue of the Manuscripts in the Library of The Linnean Society of London.—Part 2. *Caroli Linnaei Determinationes in hortum siccum Joachimi Burseri. The text of the manuscript in the Linnaean Collections*, edited by Spencer Savage. (Pp. 78.) (1937.) 13*s.* 4*d.* net.

—— Part 3. *Synopsis of the Annotations by Linnaeus and contemporaries in his Library of Printed Books.* By Spencer Savage. (Pp. 20.) (1940.) 6*s.* 8*d.* net.

—— Part 4. *Calendar of the Ellis Manuscripts. (The Correspondence and Miscellaneous Papers of John Ellis, F.R.S.)* By Spencer Savage. (Pp. vi, 104.) (1948.) 25*s.* net.

Lectures on Taxonomy: *Lectures on the Development of Taxonomy* (1948–49), and *Lectures on the Practice of Botanical and Zoological Classification* (1949–50). 4*s.* 0*d.* each.

A History of The Linnean Society of London. By A. T. Gage. (Pp. viii, 175, Pl. 11). (1938.) 6*s.* 4*d.* net.

A Prodromus of the British *Hieracia.* By H. W. Pugsley, (Extracted from *J. Linn. Soc., Bot.*, No. 351 (Vol. 54) pp. iv, 356, and 17 plates.) (1948). 60s. net.

An Introduction to the British Mesostigmata (Acarina) with Keys to Families and Genera. By G. Owen Evans. (Extracted from *J. Linn. Soc., Zool.*, No. 291.) (1957.) 6*s.* 0*d. net.*